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STUDIES OF ANIMAL SPEECH.

By Prof. E. P. EVANS.

THE enthusiasm with which Mr. Garner has devoted himself to the study of simian speech, and the general interest excited by his discoveries, naturally suggest a comparison of his investigations with those of his predecessors in this department of linguistic research. Perhaps the most serious and scientific attempt of this kind was made nearly a century ago by Gottfried Immanuel Wenzel, who published at Vienna, in 1808, a volume of 216 pages entitled Neue auf Vernunft und Erfahrung gegründete Entdeckungen über die Sprache der Thiere (New Discoveries concerning the Language of Animals, based on Reason and Experience), in which he maintained that the lower animals are capable of expressing their thoughts and emotions by means of articulate sounds, and that these utterances are not only intelligible to their kind, but may also be understood by man, indicated by alphabetical signs, and thus reduced to writing. He made a list of the sounds uttered by thirty different birds and beasts, and prepared a dictionary of more than twenty pages, to which he added a number of translations from animal into human speech. These so-called translations are very free, and give merely a paraphrastic statement of what he supposes to be the significance of certain canine and feline tones, the versions being confined to his interpretations of the colloquies of cats and dogs. As an illustration of his proficiency in this language and the practical value of such knowledge, he relates an incident, which sounds as though it might belong to the ancient and fabulous literature known to the Germans as *Jägerlatein*, or hunters' Latin. He once went to visit a friend, who was a great huntsman, but on learning that he

had gone out with his gun waited for him to return; meanwhile he took a book and sat down under a tree near a pen in which some foxes were confined. Suddenly he heard them utter certain sounds which according to his vocabulary were expressive of surprise and joy, and after listening for a time came to the conclusion that the foxes had discovered some means of escape and were exulting over the prospect of regaining their freedom. When the hunter returned, Wenzel informed him of what he had heard and advised him to look into the matter, but was only laughed at for his credulity and assured that the pen was perfectly secure. They went into the house, where they were taking some refreshments and talking about other affairs, when a servant rushed in greatly excited and announced that the foxes had escaped.

Wenzel admits that the language of animals is extremely simple and limited, and consequently monotonously repetitious; the same combination of sounds uttered with a stronger or weaker intonation serves to denote a variety of mental states and must be largely supplemented by lively pantomime. In conclusion, he has eighteen pages of what he calls an "animal pathognomic-mimetic alphabet," showing the value and function of each part of the physical organism, from the teeth to the tail, as a vehicle of expression. Dogs and cats fairly bristle with strong emotions, and birds show their ruffled feelings in their feathers and wax eloquent with their wings. Wenzel is convinced that every species of animal has its own dialect, which is to be regarded as a modification of the common or generic language of the race to which it belongs. Thus he seems to think that the zebra would understand the ass more readily than the horse, because the first two are more closely affiliated, although all three are endowed with equine speech. The same principle applies to the different varieties of the domestic hog in relation to other suilline quadrupeds.

As an example of the extent to which animals may acquire a knowledge of human speech he prints a communication from a clergyman who had taught his dog to fetch books from his library in an adjoining room. "Fido," he would say, "on the table near the window are a quarto, an octavo, and a duodecimo; go and get the quarto." Fido never failed to bring the volume designated. He had trained the dog to perform this service by showing him a book and saying very distinctly and repeatedly quarto, octavo, or duodecimo, and then laying it down in the library and making him fetch it. In the same manner the dog was taught to bring many other objects, the names of which he seldom confounded or misunderstood. The clever animal could also be sent on errands. "Fido," the clergyman would say, "go to Mr. B. and tell him that I shall call upon him to-day." Thereupon Fido ran to Mr. B.'s house and on finding him gave three short barks, which were per-

fectly intelligible to the person thus addressed. If any one called when the clergyman was out, Fido barked once; and he did the same if his master did not wish to be disturbed and bade him tell the caller that he was not at home. He announced a visitor by scratching on the door and barking twice. A Bavarian family at Munich has a dog that deems it highly improper for gentlemen to wear their hats in the house, but is sufficiently gallant not to find fault with ladies for doing so. An American, who wished to test the animal's discriminating sense of the fitness of things in this respect, entered the room and sat down with his hat on. The dog looked at him disapprovingly for a moment and then began to bark, with eyes intently fixed upon the hat. As the unmannerly visitor continued the conversation without paying any attention to these admonitions, the dog sprang up and, seizing the hat by the brim, pulled it off and quietly laid it on a chair.

Wenzel also tells the story of a dog whom his master used to send to the market for meat, and who would stand before the kind of meat he was instructed to get, beef, mutton, or veal, and bark once, twice, or thrice, according to the number of pounds desired. The butcher filled the order, and the dog trotted home with his purchase and the cheerful consciousness of having done his duty. Wenzel's little book is full of interesting anecdotes illustrating his subject, and has a frontispiece representing a landscape, resembling the traditional pictures of the garden of Eden found in old Bibles, with an ape, a dog, a horse, and a bull in the foreground, and the legend underneath: "They do not lie; their speech is truth."

The French physicist, R. Radeau, in a work on acoustics, published in 1869, treats incidentally of the language of animals, which he thinks one could, by careful observation, learn to understand and even to speak with fluency. Mersenne, in his Harmonie Universelle, asserts that men speak from a volitional impulse and utter vocal sounds in the exercise of a power of the mind which they are free not to exercise unless they choose to do so, whereas the lower animals use their voices under the influence of natural necessity, howling, shrieking, singing, etc., because under the circumstances they can not do otherwise, being subject to forces which they are absolutely unable to resist. The vexed question of the freedom or necessity of the will in human action, which metaphysics has vainly endeavored to solve, has been reopened by natural science and evolutionary biology and is now discussed on a broader basis and with the prospect of positive result. Whatever may be the final issue of these investigations, it is certain that the old Cartesian distinction between man and brute in this respect can no longer be maintained. Radeau is right in rejecting Mersenne's theory as involving a too subtile psychological

distinction and in declaring that his doctrine of natural necessity might be applied with equal force to many an inveterate gabbler who can not hold his tongue.

In this connection he relates the following anecdote on the authority of Jules Richard: In 1857 this gentleman had occasion to visit a sick friend in a hospital, where he made the acquaintance of an old official of the institution from the south of France, who was exceedingly fond of animals, his love of them being equaled only by his hatred of priests; he claimed also to be perfectly familiar with the languages of cats and dogs, and to speak the language of apes even better than the apes themselves. Jules Richard received this statement with an incredulous smile, whereupon the old man, whose pride was evidently touched by such skepticism, invited him to come the next morning to the zoölogical garden. "I met him at the appointed time and place," says Mr. Richard, "and we went together to the monkeys' cage, where he leaned on the outer railing and began to utter a succession of guttural sounds, which alphabetical signs are scarcely adequate to represent—'Kirruu, kirrikiu, kuruki, kirikiu'—repeated with slight variations and differences of accentuation. In a few minutes the whole company of monkeys, a dozen in number, assembled and sat in rows before him with their hands crossed in their laps or resting on their knees, laughing, gesticulating, and answering." The conversation continued for a full quarter of an hour, to the intense delight of the monkeys, who took a lively part in it. As their interlocutor was about to go away, they all became intensely excited, climbing up on the balustrade and uttering cries of lamentation; when he finally departed and disappeared more and more from their view, they ran up to the top of the cage and clinging to the frieze made motions as if they were bidding him good-by. It seemed, adds Mr. Richard, as though they wished to say, "We are sorry to part and hope to meet again, and if you can't come, do drop us a line!"

No one who has observed the actions and listened to the utterances of a clever parrot will accept Mersenne's assertion that the exercise of the vocal organs of animals is not free, but subject to natural and irresistible necessity, or that speech is in a greater degree the product of inevitable causation in the mouth of the cockatoo than in that of the cockney. Humboldt states that, after the Aturians on the Orinoco had become extinct, the only creature that could speak their language was a very aged parrot, condemned by adverse fortune to spend the remnant of its days in comparative solitude as the sad survivor of a once powerful tribe. From a philological point of view, the venerable bird was as interesting a character as the old Cornish woman with whose decease, some years ago, the dialect of her people ceased to be a

spoken tongue. It is also a historical fact that when, in 1509, the Spanish freebooters Nicuesa and Ojeda wished to surprise the village of Yurbaco, on the Isthmus of Darien, in order to capture a cargo of slaves, the vigilant parrots in the tops of the trees announced the approach of the enemy, and thus enabled the inhabitants to escape.

Perhaps the most cultivated and certainly the most celebrated parrot of which we have any record belonged from 1830 to 1840 to a canon of the cathedral of Salzburg, named Hanikl, who gave the bird regular instruction twice a day, from nine to ten in the morning and from ten to eleven in the evening. The parrot made rapid progress in the development of its mental faculties, and soon showed what a remarkable degree of intelligence it is possible for such a creature to attain under systematic tuition. The sayings and doings of this parrot which lived fourteen years after Hanikl's death and died in 1854, have been reported by a number of careful and competent observers and are unquestionably authentic. One day, as some one entered the room, it cried out in a harsh tone, "Where do *you* come from?" On seeing that the person was an ecclesiastical dignitary, it added, apologetically: "Oh, I beg pardon of your Grace; I thought it was a bird." It took part in general conversation, and was sometimes so loquacious that it had to be told to stop; it was also fond of talking to itself, and imagining all sorts of exciting scenes: "Beat me, will you? Beat me, will you? Oh, you rascal! Yes, yes, that's the way of the world." It whistled tunes and sang various popular songs, and even learned an entire *aria* from Flotow's opera of Martha.

A parrot of the same species (*Psittacus erithacus*), ash-gray, with scarlet-red tail, is now in the possession of M. Nicaise, a member of the Anthropological Society of Paris. This bird is nearly fifty years of age, and endowed with wonderful versatility of intellect. It imitates to perfection all the calls and cries of the street, and when in 1870 it was sent away from the beleaguered city into the country, it came back with its repertory immensely enlarged, having learned to reproduce the whistle of the quail, the hoot of the owl, the merry scream of the magpie, the crow of the cock, the cluck of the hen, and the tones of a great variety of wild birds and domestic fowls and quadrupeds. One of its histrionic masterpieces is the phonetic representation of the killing of a pig which it witnessed nearly a quarter of a century ago, but of which it has not forgotten a single characteristic grunt or squeal. Nothing is omitted, from the deep gutturals, alternating with piercing shrieks, as the porker is dragged to the place of slaughter, to the last faint groan of the dying animal. Indeed, the reproduction of the scene is so intolerably realistic, that the persons present are fain to stop their ears and to bid the bird keep si-

lence. It listens attentively to any conversation that is going on, and expresses its approval or astonishment by exclaiming "Oh!" or "Ah!" and always at the appropriate time or place. If any one tells a funny story or gets off a joke, it laughs with the rest of the company, although this outburst of merriment is doubtless due, not so much to a humorous appreciation of what is said, as to the contagion of the general hilarity. When it wants something, it calls its mistress by her Christian name, Marie, and, if she does not come at once, calls her again with a sharp tone of impatience. Once, when a firebrand fell on the hearth and filled the room with smoke, it cried, "Marie! Marie!" in a voice indicating extreme anxiety and alarm. This parrot is a provident creature, and when taking its dinner always lays aside a piece of bread and jam for its supper, thus showing that it has the power of looking before and after, which Shakespeare deems a peculiarly human attribute. It not only sings songs correctly, but also inprovises musical compositions, which it renders each time with new variations, and performs, as M. Nicaise assures us, "with a taste and style and spirit that might excite the envy of any pupil of the conservatory." The fact that these pieces invariably close on the tonic or keynote proves that all the modulations are referred to the fundamental tone of the chord, and gives evidence of a musical feeling and sense of harmony such as only human beings are usually supposed to possess. These improvisations are whistled, and sound as though they were played by a flute, the performance being uniformly preluded with runs and trills and other vocalizations.

The parrot is an exception to the rule that the period of infancy is longest in the most intelligent creatures. Its babyhood is, in fact, very short, although its average life seems to be somewhat longer than that of a man. It attains the full splendor of its plumage and is pubescent at the early age of two, and often survives all the members of the human family in which it has been reared, outliving even the children much younger than itself. During all this time it retains its mental plasticity and progressiveness, never ceases to learn, and goes on developing its inborn capacities from the beginning to the end of its prolonged existence. It is quite as inquisitive as the monkey, and quite as capable of close and continued observation. Merely through its association with man it is constantly making new acquisitions of knowledge, and there is no telling what might not be accomplished in this direction by systematic instruction carried on through successive generations.

If Mr. Garner's object had been to ascertain how far animals can acquire the use of human speech and what effect such discipline would have in enlarging their intellectual faculties, he

would have done better to choose parrots instead of monkeys for his experiments; but as his purpose is to learn the language of animals, and not to teach them his own, he has done well to select apes as the objects of his study. It must be confessed, however, that the results of his investigations, embodied in his volume recently published, are rather disappointing, and are, in fact, less comprehensive, although doubtless more accurate, than the observations made by Wenzel at the beginning of the present century. He is prone to lay great stress upon matters that are really of no importance whatever, as, for example, when he discovers that "No," accompanied by a shake of the heads is the sign of negation, and adds, "The fact that this sign is common to both man and simian I regard as more than a mere coincidence, and I believe that in this sign I have found the psycho-physical basis of expression." It is difficult to perceive how a logical thinker could draw such a sweeping conclusion from so slight premises. If he finds that gorillas and chimpanzees in their native wilds, unaffected by human associations, express dissent by shaking their heads and shouting "No!" it will be a fact well worth recording.

Mr. Garner's superiority to his predecesssors in this department of linguistic research consists in the greater excellence of his material rather than of his mental equipment. The possession of the phonograph alone gives him an immense advantage in this respect, by enabling him to record and to repeat the utterances of monkeys with perfect accuracy. Armed with this scientific weapon of phonetic precision and all the instruments and appliances which modern invention has placed at his disposal, he may perhaps completely conquer a province of investigation hitherto but partially explored, and, by making important contributions to zoöglottology and working out a system of alphabetical signs for the language of the anthropoid race, become the Cadmus of the simian world.

A Bengali in India has made a contribution toward the expenses of a "snake laboratory" which it is proposed to establish in Calcutta. The work of the establishment will include the scientific examination of supposed cures for snake-bite, and the investigation of the properties of the snake poison. The laboratory will be the only institution of its kind in the world.

The expedition of Sir William Macgregor to Mount Owen Stanley in New Guinea found a remarkable native bridge spanning the Vanapa River. It is a woven bridge, suspended from trees on each bank, and is similar in every respect to the bridges built by the Malays of Sumatra and the Dyaks of Borneo. The view of it given in Mr. J. P. Thomson's British New Guinea shows it to be an elegant and picturesque structure.

LEARN AND SEARCH.*

By Prof. RUDOLPH VIRCHOW.

OUR university has during its existence, now for more than eighty-two years, celebrated the beginning of a new university year in a peculiarly solemn manner. This October day is the one among the festivals it observes which invites it to enter into self-contemplation, to a review of its acquired results, to a testing of the ways it has struck out, and again to the consideration of new problems and to a look into the future. Have we solved the problems that are set before us? Have we made a faithful use of the means for training youth for the highest objects of the state and of manhood? Can we surely expect that the hopes which we and the Fatherland have built on our work will be realized? It is incumbent on the new rector to be the interpreter of these problems. But whose mouth is eloquent enough to give common expression to the often widely diversified thoughts of his associates? How few of us succeed in obtaining even only a general view of the ever newly changing phases of single special branches! None of us, we often confess, is a bearer of all knowledge. Each of us can do no more, with the best will, than judge from the point of view of his own branch, of his own single experience out of the whole course of studies at the university. Hence the temptation is pressing to make his own branch rather than the generality of the studies the subject of his review. I shall endeavor to avoid this rock.

The confidence of my associates has called me to this high position forty-six years after I entered this faculty as a *privat docent*, and after I have been active forty-three years as an *ordinarius* in a foreign university and here. Great changes have taken place, not only in public affairs, but also in knowledge—greater than in hundreds of years before. All the single fields of human activity have been transformed, many fundamentally, or at least subjected to the incisive attacks of criticism. How could one who has participated busily in public life have passed through so great experiences without realizing it and without disturbance? Yet university life is not isolated amid the general intellectual life of the people. We are obliged to look around from our instruction upon instruction in general, the elementary and preparatory instruction which youth eager to learn bring to us, as well as upon the instruction in the various higher or technical schools, one after another of which has developed the intelligible effort to be, or at least to be called, a high school. To

* Rector's address at the Friedrich Wilhelm's University, Berlin, October 15, 1892.

the lower institutions the university is a perpetual association to prepare their pupils so that they shall receive our instruction with full understanding; for the higher schools, it is a model after which they may shape their methods and regulations. On the other hand, the university is called upon to introduce to the state and society successive new generations of young, well-prepared men, who, filled with arranged knowledge, impelled by moral earnestness, preserve and bear the sacred flame of learning through all the perplexities and dark passages of daily life.

There was a time when this sublime position of the university was not only generally recognized, but was also distinguished by great prerogatives. Many of them have since been lost. We have, perhaps, only temporarily, but still happily, passed the days when the strongest attacks were made against the universities and the narrowest limitations were imposed on their freedom. But we will not forget that even this university, which was founded in the most difficult period, in order, according to the word of its founder, King Friedrich Wilhelm III, to be "the nursery of a better future," was subjected to a suspicious and close watch. Various motives worked together to bring about this unhappy condition. One of them, and one which you, dear fellow-laborers, may contemplate with advantage, lay in the behavior of many of the students, and consisted in a widespread misunderstanding of the purpose of the study and the position of the student.

No less a person than Johann Gottlieb Fichte first occupied the position from which I speak to-day. In the memorable address "On the One Possible Disadvantage of Academic Freedom" (*Ueber die einzig mögliche Störung der akademischen Freiheit*), which he delivered as the first chosen rector of our university on October 19, 1811, he spoke the significant words, worthy of being taken to heart: "He only is a student who just studies." With prophetic mind he described whither the course tends, when the student, instead of making it his chief purpose to learn, instead of "sinking, as he ought, his whole thought and mind in learning," spends his time in nursing antiquated traditions of a special privileged condition of students and in maintaining supposed prerogatives. It is sufficient to refer to this address, which every student may be advised to read. Fichte at that time expressly disclaimed speaking of conditions which existed at this university, but referred to the cases of other universities; and the earnestness of his admonitions reveals that he regarded the danger as menacing, and, in fact, as so menacing, that he saw in it the "one possible disadvantage of academical freedom."

The severe crisis which came on a few years later and involved all the German universities has at last passed away, and it has, as we recognize with thanks, left unscathed the two

chief features for which we have every reason to be proud in a comparison with other nations of Europe—freedom in teaching and freedom in learning. Teachers and pupils have still that independence and self-reliance which promote vigilant responsibility and exclude strange control. The freedom in teaching in particular, which was preserved till the dissolution of the German Empire through the special concessions of the emperor and the nobles, has in our time become a constitutional right. The free choice of the rector by the regular professors has also remained to us, and the corporate character of the university has not been attacked.

Several other privileges, indeed, which originated in the time when the student body was almost sovereign and the customs of the middle ages determined the form of the student's life, exist no more. The academical jurisdiction has been reduced to a few disciplinary rights; our scepters, which were conspicuous on days like this, are more ornaments than real insignia of power. The student is now in full sense subject to the civil law. He is a citizen like the others, and he knows that he has no other privilege than the right of freedom to learn preserved to him on the ground of what he represents, and the right won by proficiency in university studies of obtaining money and a part of the highest positions in the state. In other respects we have no academical freedom different from general civic freedom. The student has no special right. The academical citizen like the citizen of the state looks for the source of his right in the constitution of the state. But this constitution has given him more rights than he formerly had; especially the right, under limitations prescribed by the constitution and the law, to participate in political life without being subjected to any exceptional rule.

Therefore, dear fellow-students, take the sincere counsel to pursue learning as your first and most important object, with full knowledge of all its results and with devoted earnestness. Self-evident as this advice may seem to be, experience teaches that it can not be repeated too often and too impressively. This is true as well for the later semesters as for the first. The more difficult and comprehensive the branch the entering student selects, the earlier should the methodical study begin, for the instruction of the later semesters is comprehended only on the basis of the earlier instruction. The temptation to the young student first to enjoy academical freedom in not-learning is certainly very great. To one who passes from the constraint of the gymnasium into the golden freedom of the university it is a privilege to stretch his limbs and to conduct himself without regard to later things. We all know this, and are accustomed to exercise "academical indulgence" toward this way of using academical freedom. But there

must be limits to this indulgence, for it is not really academical freedom as we understand it and as the state should understand it. "Academical freedom" does not mean "freedom in not-doing" or "freedom in pleasure, or in the gratification of the passions," but "freedom to learn." This is real academic freedom, and the university has been opened to students for its exercise.

Neither teachers nor scholars should forget that the object of the university is a very high one, namely, general scientific and ethical cultivation and full knowledge of the special branch pursued. Once at least in his life, at the close of his university career, the cultivated young man should be so far advanced that his knowledge, especially in his own branch, should correspond with the average condition of scientific research. If he does not succeed in that, there is little hope that he will ever become an honored specialist in the circle of his associates. He has every prospect of continuing a bungler all his life. Let no one, therefore, be deceived: only in exceptional cases does a period of freedom to learn like that normally possessed by the academical citizen return in later life.

To the exercise of this freedom the desire to learn is essential before everything else. Whoever desires to learn at the university will have to decide at once what and how he will learn. The indifferent pupil shirks this decision. His choice does not really concern the kind of learning; it wavers principally between learning and not-learning. The university possesses no means of compulsion to enforce learning. The means of discipline and regulation at its command are not adequate to secure participation in instruction; only the medical faculty has in its examinations obligatory provisions which are adapted to secure a certain order in the succession of lectures and exercises. Yet experience teaches that complete success can not be reached without the desire to learn. How can this desire be aroused?

In so large a university as ours the personal influence of the teacher on individual students is naturally very limited; only special conditions can enable him to form close relations with a smaller circle of hearers, or exceptionally with single hearers. His influence is, therefore, chiefly exercised upon the mass of students, and he often first learns from a later examination how little of this influence the individual has received. We can declare with pleasure that the number of hearers who followed the instruction with ardor and success, even with distinguished success, is not small. But it would be a mistake to conceal the fact that the complaint of the teacher very often is that his trouble has been in vain. Many go further, and assert that a progressive diminution in the work accomplished by the students may be remarked.

This is especially the case in those branches the substance of which is all strange to the newly entered student, and is endowed with an oppressive copiousness of new ideas, as, for example, in jurisprudence and medicine. Precisely in these branches is the course of the student in the first semester often decisive for his whole development, and indeed for his whole after life. For in them one lecture is built methodically on another, and no one can properly understand the superstructure without having become acquainted with the substructure in all its parts. Else there arises a piece-work of fragmentary knowledge without proper foundation. All the teacher's later influence can not fill up the gaps.

Doubtless the difficulty of the matter contributes to make beginners waver in their zeal; and yet it is the beginners on the gaining of whom all depends. Does the responsibility for a pause in learning occurring so often in the first semester rest upon the university teaching? Such a reproach can not be raised, even on the strictest investigation, and it has not been raised to my knowledge, at least not in a corresponding generality. On the contrary, all the considerations lead to the question of preparatory training. This point is at this instant engaging most extensive consideration. The attention of all cultivated persons, and no less of the Government, is directed to the question of what changes in the instruction in the higher schools are demanded in order to reach that measure of preparatory training which can assure a wholesome progress in the studies of the universities. It would far pass the scope of my address to discuss this highly important question in all its parts. The debate goes on concerning the subjects of instruction, the amount of time which should be given to each, the method of teaching, and finally the amount of work to be laid upon the students, and also upon the teacher. The experience of the university teacher has been large enough to enable him to form a judgment upon the majority of these questions. It will be sufficient for the present discussion to touch upon only a few of the less frequently mentioned points.

The university teacher has before everything else two demands to make upon the higher schools, which are in close connection with each other. He should require that the *abiturients* bring with them the desire to learn and the capacity for independent work. The proof of positive knowledge of any particular sort should give way to these demands. Individual faculties will make various requisitions with reference to them; but it will be hard to show a serious difference concerning the main point.

The desire to learn is originally present in every normally endowed child. We daily witness the joy of the infant when he succeeds in comprehending a new thing or perceives some new

action of his organs. His pleasure increases with every advance that he makes. This property is innate. How it is exercised is in the first place dependent on the condition of his organs. Many diversities of behavior appear among children early, according as they are limited by inborn, and often inherited, differences in their faculties.

Is this property peculiar to children alone? Surely not. It abides in the man till his mature age, provided his organs are normal, and as long as no disturbance or interruption by outer influences intervenes. What pleasure does even the learned man experience when a new field of knowledge is unlocked to him; even in his old age, how enlivened is his thirst for learning when he succeeds in getting a glance into new series of phenomena of Nature or of the human mind which had been previously incomprehensible or inaccessible to him! How does it happen that young, cultivated men, under training to become academical freemen, escape this general human property? It is in them without doubt, but has not rarely been repressed by some objectless treatment. Then the thing to be done is not to call it out for the first time, but to revivify it.

From the desire to learn, when well directed, is developed the desire for knowledge. Not satisfied with the knowledge of a fact, with the perception of a phenomenon, the desire to learn urges on to the understanding of it. It searches for the connection of phenomena and processes, their history and causes, and is never quite satisfied till it has grasped their genetic and causal relations. This is the mark of a real desire for knowledge. With it comes the beginning of research. A disposition to investigate can be recognized in the child to the extent that it divides the object it has in hand into its parts and tries to put them together again into a whole; or it imitates a movement, to learn what it must do to bring it about. Training thus finds all the elements present; it has only to use them and direct them in methodical ways. This comes to pass when attention is fixed on the connections, interest is stimulated, the study is directed to the principal fact and diverted from the subsidiary ones.

We can now raise the question, Does this take place in our schools? Even in the lower schools the desire for learning is so greatly perverted that with no small portion of our people, not the love of knowledge, but only its lowest form, curiosity, is cultivated—that disposition which is satisfied with a superficial and therefore incomplete comprehension, following which attention is directed to new objects. Thus, an innate and naturally worthy property is misdirected and brought to a form of expression which is at least purposeless and not rarely injurious.

When the love of knowledge is awakened in the childish mind

and the child is also led to a consideration of genetic and causal relations, attention should be directed to historical events. With right that instruction which points at most to a more formal transmission of precepts—religious instruction—is not limited to mere dogmatic teaching, but seeks in sacred history a means of learning. But nothing is so highly adapted to such teaching as what is called natural history, in which real objects are dealt with, and genetic processes may be immediately demonstrated. Our Folk schools are making daily progress in observational instruction, and it is only to be desired that the application of mere pictures may be supported by illustrations from real objects.

In the higher schools teaching of the languages has had the lion's share from the beginning. As the gymnasia grew out of the Latin schools of the middle ages, the preference of Latin has remained their constant inheritance. The Greek, the introduction of which is due to the humanists, has taken a place by its side. This circumstance has had the happy result, we thankfully recognize, for enlightened Europe, of gaining for all those peoples who have had a part in it a common basis of cultivation which has contributed more than anything else to promote mutual understanding and the feeling of fellowship. During a long time the general use of the Latin language by the learned has in the most opportune manner facilitated the intercourse of all literary men.

The condition has now become different, very different; and even those who, fully recognizing the highly beneficial influence of the classical languages upon European civilization, desire a continuance of their study, must grant that it is impossible to restore the old relations. The national languages have come into their natural right, and much as we may deplore the increasing polyglot character of learned works, and evidently as it concerns us that we are not qualified to read a multitude of excellent treatises in the original, we must still recognize that no power in the world is competent to produce a change within a conceivable time. Our literary schools only exceptionally furnish graduates who can speak Latin or write a fluent Latin essay; and the universities have been forced, contrary to their inclination, to remove the Latin language from their courses of instruction and from practical use. The confusion of tongues has entered the learned world and secured its sanction.

It was from the beginning on the weak side of the humanistic institutions that they preferred Latin. It must be conceded that they could not do otherwise. They found the Latin the universal language of the Church and the land. They were Latin schools. They simply continued what had been the general praxis through a thousand years of exercise. But they received with it

an element of weakness. For the classical writers of Rome were far behind those of Greece in their achievements; indeed, the best among them owed their culture to Greek predecessors, and the schools of Athens always held the first rank in the esteem of men. Their teachings constitute the background of all literary achievement. Our Western civilization has received its most peculiar moving thoughts, its current forms, from Grecian literature. Homer, Aristotle, and Plato have continued to be the teachers of the peoples till our days.

The balance of decision in this conflict is now swinging hither and thither. Professional interest in the Latin has declined since the Greek writers have been read again in the original, yet the Latin language has remained the principal subject of instruction. Its reach, however, has constantly become less. Since the use of language as such has steadily diminished, we have let rhetoric drop and have limited ourselves more and more to grammar. Indeed, grammatical teaching has gradually become so predominant that even the Latin essay has been reduced to a pious desire. We have thus reached a turning point with the classical languages. Schooling in grammar is not that aid to continuous growth which our youth need. It does not produce that desire to learn which is an essential preliminary to independent advancement; on the other hand, it is evident that it has become an object of aversion to many pupils, and perhaps for more parents. Greek has already been half surrendered. No one expects any longer that the mass of the pupils coming from the schools shall be so far advanced as to be qualified to take up the independent reading and explanation of the Greek writers. Medical men had apparently the most reason for regret, for their science is the only one which has grown up during more than two thousand years uninterruptedly on the basis of the Greek writings. But it can not be denied that Hippocrates and Galen offer so few points of touch with present doctors, although these piously adhere to the Greek terminology, that the study of them is of the least significance to the understanding of pathological processes. The real value of Greek literature, moreover, lies not in its technical parts, but rather in the philosophical and poetical departments, the influence of which in cultivation is for the moment underestimated.

An important innovation has meanwhile taken form in the philological department, which we may proudly praise as eminently a German achievement: I mean the study of comparative linguistics. With it a properly genetic element became valid even in philology. Wonderful results, of inestimable value in the history of human civilization, are now in prospect. Ever new researches keep the probability in view that comparative linguistics will continue to be a regular constituent of the higher education.

But it will evidently be attainable in its details only to university students. The decision of what shall be prescribed to the higher schools concerns, therefore, only the two classical and the modern languages. The university teacher has, in respect to this decision, to insist that, whatever language is prescribed, it shall be so taught that the pupil shall learn to work independently in it, and that he preserve his pleasure in the work. It remains to be seen whether new methods of teaching will promote this object.

We can now show upon this subject that there are other fields of teaching, the methods of which have been so well shaped out that they are in a condition completely to carry out what is needed. They are mathematics, philosophy, and the natural sciences. They have, on the one hand, so rich and diversified a content that they ever stimulate the love of knowledge anew, and on the other hand they are so well adapted to an ever more extensive cultivation as to afford a rich opportunity for genuine research. It is thus made clear that occupation with them affords the young mind so sure a preparatory training that it can make itself at home with peculiar ease in every faculty.

Instruction in the branches we have named, at least in their elements, was introduced long ago in our higher schools. Only the measure of the knowledge which should be prescribed as the purpose of this instruction has been variously fixed at different times. The opinions of teachers as well as of the controlling state officers have frequently changed; and the excessive tendency of these men toward the philological course at last always borne against the extension of the designated branches. Only the extreme necessity of satisfying the demands of the rapidly advancing technical interest and the industries gaining strength evenly with it, irresistibly forced concessions, and when it was believed that these could not be carried in the humanistic institutions, a separation was decided upon. Hence arose the polytechnic schools and the gymnasia, and as a further result the technical high schools.

A final peace has not been reached in this way. Our age is in the midst of the fight over the claims of particular kinds of high schools. The call is ever anew rising for specially organized schools, and before everything for a far-reaching reform of gymnasial teaching. Not all these demands can be justified. The universities have in most cases not sustained the claims of the real schools for a general admission of their graduates. As we have already observed, the interests of the individual faculties in the kind of preparation of their students are not identical. Those faculties which look in their teachings for immediate support in philological aids can not declare themselves satisfied with a preparation which has pushed the ancient languages more or less into

the background. Those to the understanding of whose branches the ancient languages as such contribute directly no essential part have to consider how far a full training in mathematics and science can furnish for their branches and for general cultivation as well an adequate substitute for the want of classical training. Experience has not supplied a decision on this point. It can be remarked only that among the foreigners who have been admitted to our classes are many who have not enjoyed a gymnasial training in our sense, and who yet attend the lectures with commendable interest and with evident good results.

There undeniably exists an essential difference in respect to the demands which individual faculties have to make on the preparation of those coming to them from the schools. The future must teach us whether a single kind of higher schools can satisfy these various demands. But a definite answer can already be given respecting one of them. If the classical languages are no longer competent to supply the unifying bond that formerly connected all the different directions of learned culture, a substitute for them can be found only in that golden triad of mathematics, philosophy, and science on the development of which all modern civilization touches.

It is a matter of secondary importance for this discussion whether the roots of this culture should be sought still further in the East, in Egypt or in Babylonia. The continuity of Western civilization actually begins for us on the western coasts of Asia Minor with those Ionian Greeks who first laid mathematical study of the heavenly bodies at the base of their discussions concerning the universe, and who produced the first natural philosophy, in which all that man knew about Nature was reduced to a harmonious picture. In this philosophy lies the actual beginning of that universal consideration of the world which has been significantly called "world wisdom," and which has gradually led to a fundamental transformation of the old conceptions of the heavens and the earth and of man himself. That is the imperishable title of the Grecian philosophy to be held in honor.

The full comprehension of this fact arose very late among the Western peoples. When, after the fall of Constantinople, Greek scholars fled to Italy, and Greek literature spread rapidly at that time, when the humanists arose in Germany, and one university after another was founded, then the independent spirit of investigation first lifted itself up in all nations. Mathematicians and naturalists abounding in original strength appeared, and philosophers were soon active in adapting the conceptions of men to the new views and in grasping the fundamentals of intellectual life.

Right in the beginning of this memorable period appeared the man whose great achievement mankind has just been festively

celebrating. Day before yesterday it was four hundred years since Christopher Columbus descried the first land of that New World in which now many millions are joyously engaged in commemorating him. For him was the enviable fortune reserved of demonstrating at a stroke, by a bold experiment, the truth of the theory that the earth is round, and of opening at the same time to human enterprise the widest field that had ever been unlocked to it. Let us at this place bring the deserved offering to his genius and his energy. Let us not forget that with him, notwithstanding his mistakes, which have been perhaps made for the moment too prominent, a new era began—an era of new thought and new traffic.

Then mental activity prevailed everywhere; great mathematicians and physical astronomers of the first rank arose; the great reformation in the Church began, and the foundations of modern medicine were laid. We are still in the midst of the movement, but it is victorious everywhere. Our age has been called the scientific age. None of the humanities have escaped this influence. Even the Roman Catholic Church, which endeavored so earnestly to restrain it, has joined it; and an appointed representative of the Evangelical Church, our honored colleague Dillmann, a few years ago spoke in his rectoral address the strong words, "A church which can not bear the light of science, or which has to temper it with colored glasses, should be laid with the dead." In fact, the modern doctrine of the universe is wholly built up on the ground of natural science, and nobody can seriously deny that it must be so.

The question is therefore permissible, whether the youth of our learned schools should not be advanced further than they are now in this new knowledge. It can be readily granted that there are still questions that have not yet been determined among the learned concerning the instruction that should be excluded from the schools and the instruction in specialties that should be reserved for the universities. But we may ask that a young man, credited with self-reliance enough to make good use of academical freedom, shall be in a condition to absorb without danger the leading facts of astronomy and biology. Can he be regarded as really mature when the whole world around him is to a certain extent closed to him? And how can university instruction effectively influence the young man if he is deprived of the instrument he needs in order to carry on his hard work?

He needs mathematics, not for its own sake, and not merely in order that he may understand the motions of the heavenly bodies; even physics has gradually become a mathematical science; and in chemistry and physiology it is becoming more and more necessary to carry out minute calculations. By their aid

the student presses into the comprehension of the inner processes, and learns not only to estimate the measure of the living forces but also to calculate them in advance, in order afterward to adjust the practical using of them.

Arithmetic alone is not enough; thought is also necessary to comprehension. Many conceive that it is not necessary to make thought itself an object of learning; but there can not be success without methodical thinking. Unfortunately, logic is one of the studies that has almost been forgotten. At most of the schools one is supposed to have done enough if he occasionally expresses a logical theorem. How can one pursue psychology who has never become acquainted with the laws of thought? How can the complicated conditions of mental life be made perceptible to the outward view? The young doctor is a little more favorably situated in respect to this matter; but what can be expected of the jurist, the theologian, and the pedagogue? Respect for philosophy is already, at least, cultivated; that is much. The disposition to learn to think philosophically will then easily be yielded to.

And now, finally, the natural sciences. What profitable objects for learning and teaching do the descriptive sciences—botany, geology, and mineralogy—afford! It is a mistake to suppose that university teachers lay most weight on systematic knowledge. Not at all. The systematic method, it is true, is learned at the universities. It does no one harm to be able to learn and distinguish a certain number of plants, animals, or stones. But the instruction proper should consist in the training of the senses, especially of the sight and feeling. At present we have to lament that a large part of our students have no exact knowledge of colors, that they make false estimates of the forms of the objects they see, and they manifest no comprehension of the consistence and exterior constitution of bodies. Nothing should be easier than to cultivate an accurate judgment concerning color and form, if besides the comprehension of the body the representation of it by a simple or colored drawing, though it were only a sketch, were learned. Every one can make such knowledge useful. It is of great value to medical men, for diagnoses of the most important conditions are not rarely dependent upon it.

The experimental sciences, especially physics and chemistry, are also indispensable in school instruction, because more than all other branches they lead to the knowledge of the genetic and causal connection of the processes, and prepare for the methodical consideration of the more difficult problems of biology. It is evident that so long as general preparation for academical studies alone is considered, only the simpler and more easily understood experiments can be dealt with in them. But every pupil who

goes out from the school should still, at least, have been introduced to these methods of studying Nature, in order to obtain a proper faculty of observation.

This enumeration of what belongs to a good preparation has been carried out to a considerable length, not because so many subjects have to be brought forward, but because in the present stage of the discussion of the relation of the university to the preparatory schools, the question of the measure of preparation that should be required for university instruction occupies the first place. In order to avoid mistakes, it may be added that to one who would limit himself to the study of his specialty, much of what has been named above may appear superfluous. But if the purpose was merely to secure a professional training, the universities would be superfluous. Then we might establish, as in France, separate *écoles*, or as in England, special colleges, or as in the Roman Catholic Church, isolated convents. If we regard the university, as is our pride, to be more than an auxiliary to the professional schools, we must also demand an effective interworking of the faculties, a general scientific course by the side of the professional course. If this, to our great regret, does not exist to the extent it ought and might, the blame for it lies in that want of preparation which I have tried to sketch, and the remedy for which I expect to follow a more exact exposition of the actual conditions.

So long as this help is not found there will be nothing left but to take up in the universities much more elementary or, at least, preparatory teaching, which burdens and degrades the instruction, and which, though sufficient in a very few cases, fails to supply the defects of preparation. The university professor has the less time for such teaching, because the university is not merely an institution for learning, but also for investigation. It is that likewise in a double sense: first, because our nation is accustomed to see scientific investigators in the university professors; and, secondly, because the state and science expect us to train at least a certain portion of the students to be investigators. In this sense we call the attendants as well as the institutions of the university academical.

The ancient name of the academy, which has received from Plato the meaning of a school working for the highest objects of mental exertion, has been applied since the times of the Medici to designate, as against the professional schools and the teaching schools, unions of prominent thinkers and investigators for cooperative work. From them have proceeded the academies of sciences. A more recent age has produced besides these all possible sorts of academies which do not concern us here. The continuous investigation of scientific problems is the appointed chief

purpose of only academies of sciences. But there are in Germany only three, at most four such academies, and they are far from sufficient to assure general progress over all the wide fields of science. A part of their function has thus fallen upon the universities, and they have performed it valiantly, sometimes gloriously. This is the reason why German university teachers demand more time than is required for the teaching in itself.

The universities have also an important function in the second direction, as I have said, in the training of new investigators and teachers. This is a very near duty, for only thus can that indispensable constituent of the teaching body, the position of *privat docent*, the nursery for future professors, be maintained and reproduced. Therefore, we should begin early to train independent workers from among the students.—*Translated for The Popular Science Monthly.*

PROTECTION FROM LIGHTNING.

By ALEXANDER McADIE.

DURING the year 1891 two hundred and five lives were lost (that we know of) in the United States, east of the Rocky Mountains, *directly* through the action of lightning. How many were lost indirectly, and how many cases there were of shattered health and more or less permanent injury, we can only surmise. The financial loss due directly to lightning was certainly not below one and a half million dollars. To get at something like a commercial estimate of the damage done by lightning in the past few years, in this country, I have made use of the Chronicle Fire Tables for the six years 1885–1890, and find that some twenty-two hundred and twenty-three fires, or 1·3 per cent of the whole number, were caused by lightning, and the total loss was $3,386,826, or 1·25 per cent of the whole amount lost by fire. During 1892 we have a record of two hundred and ninety-two lives lost. The damage may be estimated at as high a figure as in 1891. These losses are the more appalling when we recall that the year is virtually less than six months. Over ninety-five per cent of the casualties due to lightning occur between the months of April and September. It is therefore qutie pertinent at this time to discuss the question whether or not we are able to protect ourselves from lightning. Some five years ago the question would have been answered readily and with all sincerity, "Yes, a good electrical connection with the earth—a stout, continuous copper rod, for example—will suffice." To-day no such answer can pass unchallenged, for reasons which we shall see.

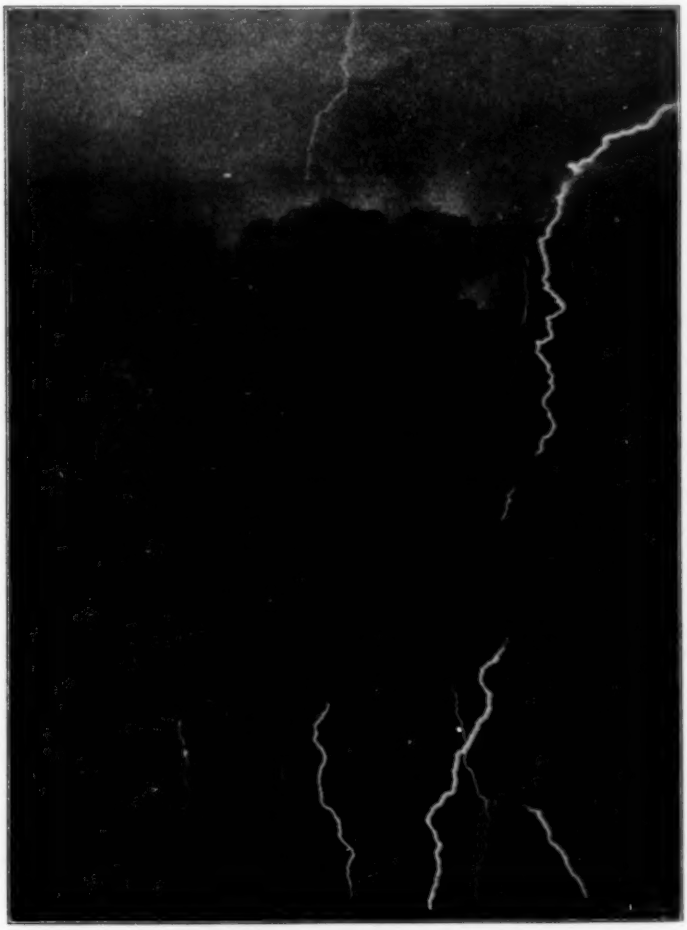
In 1888, after years of dispute, we had just settled down to the

calm enjoyment of the belief that rods did protect. The Lightning-rod Conference had shown, in quite an exhaustive report, that Faraday's position (as opposed to the opinions of Harris) was correct, viz., that the problem was one of simple conductivity; that a solid rod was better than a tube or tape (which would give greater surface with less copper); that solid volume was everything, superficial area nothing; and that, provided the metallic passage afforded the flash was continuous, any flash might be successfully carried off and harmlessly conducted to the ground.

This conference, while not strictly an official body, was one that, from the character of its members, carried great weight. It was a joint committee of representative members of the Institute of British Architects, the Physical Society, the Society of Telegraph Engineers and Electricians, the Meteorological Society, and two co-opted members.

In 1888 came Dr. Oliver J. Lodge's remarkable course of lectures before the Society of Arts upon the oscillatory character of the lightning flash. Then followed the famous dicussion at the meeting of the British Association. As this debate was one in which quarter was neither asked nor given, and the question at issue was clearly understood by all to be whether a lightning conductor, when constructed in accordance with the directions of the conference, would absolutely protect, it may not be out of place to give here a synopsis of the arguments advanced. Mr. Preece, who opened the discussion, defined the functions of a lightning conductor as twofold. "It facilitates the discharge of the electricity to the earth, so as to carry it off harmlessly, and it tends to prevent disruptive discharges by silently neutralizing the conditions which determine such discharges in the neighborhood of the conductor. To effect the first object, a lightning conductor should offer a line of discharge more nearly perfect and more accessible than any other offered by the materials or contents of the edifice we wish to protect. To effect the second object, the conductor should be surmounted by a point or points; fine points and flames have the property of slowly and silently dissipating the electrical charges; they, in fact, act as safety valves. If all those conditions be fulfilled, if the points be high enough to be the most salient features of the building, no matter from what direction the storm cloud may come, be of ample dimensions and in thoroughly perfect electrical connection with the earth, the edifice, with all that it contains, will be safe, and the conductor might even be surrounded by gunpowder in the heaviest storm without risk of danger. All accidents may be said to be due to a neglect of these simple elementary principles. The most frequent sources of failure are conductors deficient either in

number, height, or conductivity, bad points or bad earth connections; . . . and there was no authentic case on record where a properly constructed conductor failed to do its duty. . . . He personally had under his supervision at that present moment 500,000 lightning conductors, and, fixed throughout the offices (post-office

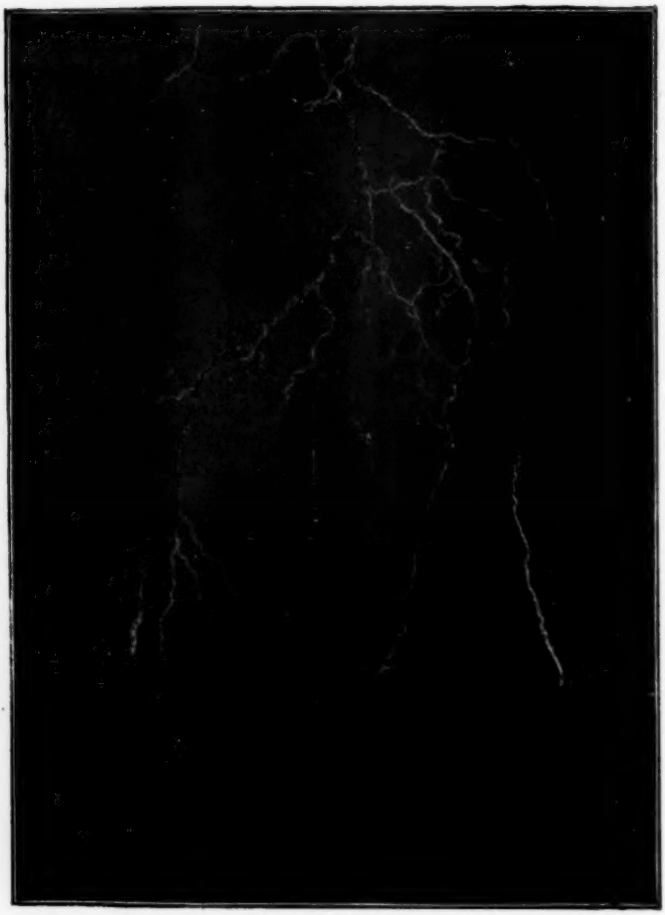


Lightning Clouds, Multiple Flash.

and telegraph), had apparatus, protected by about 30,000 or 40,000 lightning protectors."

Dr. Lodge said that "if his views were correct, very few buildings are effectively and thoroughly protected at the present time. . . . He had read carefully the Conference Report, and found a large number of entire failures; . . . one noteworthy one, a brass rod an inch thick on a steeple which was smashed to pieces and the spire destroyed. Again, the best protected building in the world, the Hôtel de Ville at Brussels, on which M. Melsens had

spent so much time and trouble. It was elaborately protected; protected by innumerable conductors with admirable earths made in a variety of ways, bristling with points all over the top—everything carried out in the most approved style, regardless of expense. Yet in the month of June the building was struck and set on fire. . . . If a lightning conductor can prevent a flash from occurring by its repellent action, well and good; but he had



MULTIPLE FLASH.

shown in his lectures that there are cases where a point has no protective action whatever, when a point could be struck by a thick and heavy flash. There were other cases where the point acts with a brush or fizz and neutralizes the electric charge without a flash. They could not always do it. And so the lightning rod has two functions; one is to be repellent if it can, and the other is to carry off a flash when it can not help receiving it.

There was a certain amount of energy which they must dissipate somehow, and they could not expect to *hocus pocus* it out of existence by saying they could conduct it to the earth. The quicker they tried to conduct it down to the earth the more searching and ramifying disturbances they were likely to get. It might be better to let it trickle down slowly by using a moderately bad conductor than to rush it with extreme vehemence down a good conductor, just as it would be safer to let a heavy weight suspended in a dangerous position down slowly rather than let it drop as quickly as possible. . . . If a man holds a lightning conductor when a flash passes down it, he will most likely be killed. . . . It did not matter about the earth; . . . a spark was likely to occur . . . he had made experiments in the laboratory with a rod very thick and a yard long, in circuit with a Leyden-jar discharge. He took a platinum wire as fine as possible to make the contrast greater, and arranged it so as to make a kind of tapping circuit; if, then, the bottom end was arranged so as to be in contact with the rod and then let the top end be an eighth of an inch away, then they would have a splendid conductor, better than any lightning conductor ever was. They would have no trouble about earth. It seemed absurd for any portion of the discharge to leave this conductor to jump across and make for the little strip of wire. Nevertheless, a portion of it did, and from every spark that went to the conductor, a side branch went to that little wire. . . . What are the conditions of a flash? He assumed that a flash behaved like experiments in the laboratory, but it was a question whether a cloud discharge was of this kind. A cloud is not like a conductor; it consists of globules of water separated from one another by interspaces of air; it may be compared to a spangle jar: when a spangle jar discharges, you have no guarantee that the whole of it discharges—it discharges in a slowish manner. It might be that there was with a cloud first a bit of a discharge and then another bit, and so on, so that there might be a kind of dribbling of the charge out of it, and they might therefore fail to get these sudden and oscillatory rushes. . . . But we must provide for the possibility of a sudden discharge."

Hon. Ralph Abercromby contributed to the discussion facts brought out by an examination of some ninety photographs of lightning flashes in different parts of the world. In one instance the whole air was filled with threads of lightning coming down like the roots of a tree from the sky. He thought it was very much a question where the area of protection would be when the whole air seemed to be pouring lightning down upon you. He would also like to find out whether buildings were struck during rain or when it was not raining. In connection with the fact that thunderstorms were confined to the lower ten thousand

feet of the air, he mentioned the fact that in Norway there were two kinds of thunderstorms: one occurred in the summer, he believed, when the lightning clouds were high, and very little damage was done; on the contrary, in winter time the clouds were very low, and the churches were frequently struck.

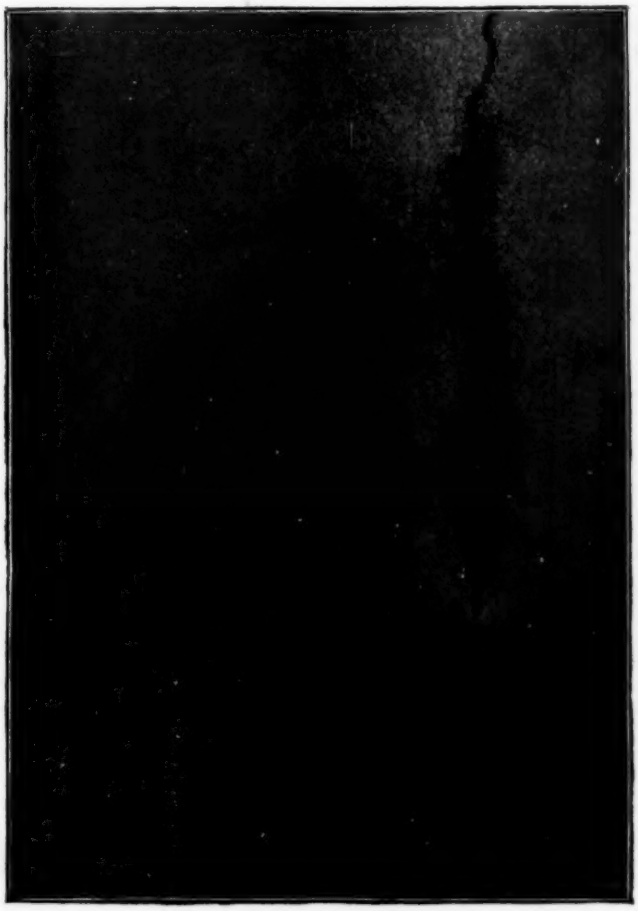
Lord Rayleigh, Sir William Thomson, and Prof. Rowland discussed the questions whether or not the experiments actually represented the actual conditions. M. de Fonveille called attention to the most extraordinary lightning conductor in existence, the Eiffel Tower, and the fact that Paris was practically free from calamities produced by lightning, because a sufficient number of lightning rods had been erected according to the principles advocated by the many official boards, substantially the same as the conference. Prof. George Forbes thought a copper alternative path better than an iron one. Sir James Douglas, speaking from an experience of forty years with a large number of conductors, was of the opinion that the rods, when properly constructed, were entirely adequate. In the matter of copper *versus* iron he pointed out the practical consideration that iron corroded rapidly compared with copper. Mr. Walker further pointed out that this corrosion of iron was not a question of weather alone, but, as in the case of the top of the chimney of a factory, there would be some chemical action. Mr. Symons brought out with respect to iron conductors that galvanizing would not entirely overcome the difficulty.

We now come to Lodge's book upon Lightning Conductors and Lightning Guards, and shall get from it a more satisfactory understanding of his experiments and deductions. He believes that the current ideas on the character of the lightning discharge were not altogether correct, because the momentum of an electric current and the energy of an electrostatic charge had both been more or less overlooked. The application of the known fact of electrokinetic momentum revolutionized the treatment of certain phenomena. The old drain-pipe idea of conveying electricity gently from cloud to earth was thus proved fallacious, and the problem of protection became at the same time more complex and more interesting. His position, therefore, is not that lightning rods are useless, but that few or none of the present types are absolute and complete safeguards; and he believes it possible to so modify existing protective systems as to afford more certain protection. The problem is one, he very clearly shows, far removed from the old idea of conduction.

To-day we know from the experiments of Hertz, Lodge, and others that when an electric current flows steadily in one direction in a conductor, its intensity is the same in all parts of the wire; but if it be of an oscillatory character—i. e., a current revers-

ing rapidly in direction—the interior of the conductor may carry far less than the surface carries.

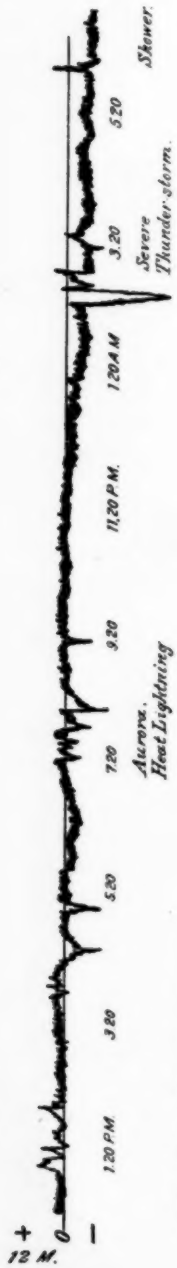
All of which goes to prove the correctness of Snow Harris's opinion (and he probably studied the effects of lightning more exhaustively than any one else) that surface was more of a consideration in the form of a protector than solid section. In this matter of the form of a conductor we follow Lodge, and prefer



IMPULSIVE RUSH DISCHARGE, SO-CALLED DARK FLASHES.

the tape to the solid rod. Increase of surface diminishes impedance; and as impedance is probably at the bottom of side flashes and spittings, that conductor is to be prefered which offers less impedance, and hence tape appears to be preferable to rod. It is also more convenient, and it has also the advantage of being made either continuous or in very long lengths. The tape must be of dimensions sufficient to withstand melting or deflagration.

"Think now," says Lodge, "of a cloud and of the earth under it as forming the two coats of a Leyden jar, in the dielectric of which houses and people exist; we now have to consider what determines a discharge, and what happens when a discharge occurs. The maximum tension which air can stand is one half gramme weight per square centimetre. At whatever point the electric tension rises to this value, smash goes the air. The breakage need not amount to a flash, it must give way along a great length to cause a flash; if the break is only local, nothing more than a brush or fizz need be seen. But when a flash does occur it must be the weakest spot which gives way first—the place of maximum tension—and this is commonly on the smallest knob or surface which rears itself into the space between the dielectrics. If there be a number of small knobs or points, the glows and brushes become so numerous that the tension is greatly relieved and the whole of a moderate thunder-cloud might be discharged in this way without the least violence. . . . But sometimes a flash will descend so quickly or it will have such a tremendous store of energy to get rid of that no points are sufficiently rapid for the work, and crash it all comes at once. One specially noteworthy case is when one cloud sparks into another and thence to the ground; or in general whenever electric strain is thrown quite suddenly upon a layer of air."



CURVE SHOWING ELECTRICAL POTENTIAL OF THE ATMOSPHERE.

Thus, then, we begin to see that much will depend upon the character of the flash. There are many flashes, I believe, that the body could experience without very serious consequences; and there are many that will rive solid granite and shatter in splinters the heaviest masonry. The impulsive rush discharge shown on the preceding page was doubtless a flash of the latter character; and on the other hand, with a kite in air during thunderstorms with a wire connection to the ground I have experienced sharp shocks with lightning

flashes, which were perhaps side branches or minor spitting-off discharges.

The risk, then, will vary with the discharge, and this is influenced somewhat by locality, and therefore the methods of protection to be employed in the Mississippi Valley would be somewhat different in character from the methods appropriate for, say, the New England coast; the frequency of thunderstorms in the one place compared with the other being about four to one. The character of the storm is also somewhat different. Then again the liability for places comparatively near is not the same. "If I urge on Glasgow manufacturers," said Sir William Thomson, "to put up lightning conductors, they say that it is cheaper to insure." These manufacturers answered the man of science more wisely perhaps than they themselves knew. Thanks to the investigations of the Prussian Bureau of Statistics, we know now that *in the main* in thickly settled communities the risk is small. We can state with some certainty that there is but little need for the erection of expensive or elaborate lightning rods upon buildings standing among others in city blocks. We do not say that such buildings are never struck. As we have seen above, under some conditions, "exposure" seems to have little to do with the determination of the path of discharge. The case is somewhat analogous to that of the trees and rocks upon a mountain side. However much they may determine the course of small streams and "trickles" down the mountain side, they are powerless to influence the course of an avalanche or land-slide. Sometimes, therefore, such buildings are struck and severely injured (and as might be expected, with seemingly good protectors, do not entirely escape); but these cases are rare, and it may, we think, be safely set down that rods upon city houses are not (as hitherto insisted upon by some) necessary. With country houses the conditions are different.

Our next question is, In flashes of ordinary intensity how much confidence may be placed in the protection afforded by a good conductor, rod or tape? Few questions have been so thoroughly discussed from a practical standpoint, and the verdict may be given in Sir William Thomson's words: "There is a very comfortable degree of security, if not of absolute safety, given to us by lightning conductors made according to orthodox rules."

If the reader is contemplating the erection of a lightning protector, these points may be of service to him:

1. Get a good iron or copper conductor of rod or tape form, preferably the latter. If copper, have it weigh about six ounces to the foot; if iron, about two pounds to the foot.

2. The nature of the locality will determine to a great degree

the need of a rod. In some localities rods are imperative; in others, needless.

3. The very best ground you can get is, after all, for some flashes, none too good; therefore do not imagine that you can overdo it in making a good ground. For most flashes ordinary "grounds" suffice; but the small resistance of even one ohm may be dangerous with an intense flash.

4. "If the conductor at any part of its course goes near water or gas mains it is best to connect it to them. Wherever one metal ramification approaches another it is best to connect them metallically. The neighborhood of small-bore fusible pipes and indoor gas pipes in general should be avoided."—*Lodge.*

5. The top of the rod should be plated, or in some way protected from corrosion and rust.

6. Independent grounds are preferable to water and gas mains.

7. Clusters of points or groups of two or three along the ridge rod are recommended.

8. Chain or link conductors are of little use.

9. Area of protection. Very little faith is to be placed in the so-called area of protection.

10. Indifference of lightning to the path of least resistance. Nearly every one who has written in late years has taken it for granted that lightning always follows the path of least resistance. This is not true. "It is simply hopeless to pretend to be able to make the lightning conductor so much the easier path, that all others are out of the question," says Lodge. This, however, requires modification. For the path will depend largely upon the character of the flash; and without doubt, for almost all flashes, a good lightning rod well earthed is the most appropriate path to earth.

11. Any part of a building, under certain conditions, may be struck, whether there is a protector on it or not. There are cases on record where edifices seemingly amply protected have been struck below the rods (not cases of defective connection), and it is now beginning to dawn upon us that (paradox of paradoxes) a building may be seriously damaged by lightning *without having been struck at all.* The Hôtel de Ville, at Brussels, perhaps the best protected building in the world against lightning, was damaged by fire, caused by a small induced spark near escaping gas. During the thunderstorm some one flash started up "surgings" in a piece of metal not connected in any way with the protective train of metal. "The building probably did not receive," says Dr. Lodge, "even a side flash, yet the induced surgings set up in it were so violent as to ignite some gas and cause a small fire." In other words, we had the condition of an "oscillator" in the cloud-flash-earth and a "resonator" that responded with its little spark.

In some experiments which we made last summer, simultaneously with some flashes, we got little sparks from a wire in the air.

12. So many people suffer so keenly from a kind of nervous alarm during thunderstorms that it is a great pleasure to be able to point out that the danger is vastly overestimated. "Heaven has more thunders to alarm than thunderbolts to punish," was the old irreverent way of putting it. One who lives to see lightning need not worry about the results.

13. The notion that lightning never strikes twice in the same place is erroneous. We have numerous cases disproving this.

14. If you are near a person who has been struck by lightning, go to work at once to try and restore consciousness. Try to stimulate the respiration and circulation, and do not cease in the effort to restore animation for at least one hour.

SUCCESS WITH SCIENTIFIC AND OTHER MEETINGS.

By GEORGE ILES.

NO tendency of these times is more marked than that toward organization. It manifests itself as plainly in scientific inquiry, literary investigation, or the cultivation of art as in the sphere of industry or finance. Let chemistry, folk lore, or musical education engage the minds of a group of people, and forthwith they unite themselves to further the interest they have at heart. The societies thus created have often manifold utility; they provide rallying centers for men and women of kindred aims, whether these aims are of popular acceptance or not; they make possible a co-operation which economizes the labor of observation or research; they furnish agencies for the spread of information accessible nowhere else; in their "proceedings" or "transactions" they publish valuable papers which otherwise would never see the light of day, and often these volumes are the sole registry of progress in important branches of inquiry or revolutionary reform. The public mind may be profoundly exercised concerning a wrong or a grievance, but its discontent is powerless until, let us say, a Free-trade League is born to serve as a nucleus around which public opinion can crystallize, which will gather and clarify argument to be echoed by a thousand friendly voices, and which will press its fight at every opportunity. Only in this way can an interest which concerns everybody only a little tell in legislation against a much smaller interest which concerns a few plunderers a great deal.

Of course, the meeting of a league or a society, whatever its objects, is determined in character by that of the organization

itself. If a purpose really worthy has prompted to union, if, avoiding faction, the best men have been put at the head, there is no reason why attractive and profitable meetings should not be held. On success here largely turns the success of the organization, for meetings should not only interest the membership, but also the general public from whom support is sought, from among whom recruits for active service must come. The judicious management of such gatherings is therefore a matter of some moment, and it well deserves more attention than it commonly receives.

Of scientific bodies in the United States, one of the oldest and in many respects the most typical is the American Association for the Advancement of Science, whose meetings in the main have been the most popular scientific assemblies held in this country. The association has suffered severely, and inevitably, by the establishment of many societies for the prosecution of branches of science, electrical, engineering, and what not, which scarcely had a name at the time of the association's nativity, fifty-three years ago. Then, too, the formation of the National Academy of Sciences has drawn off certain of the veterans who fail to recognize the claims of the association on their allegiance, who neglect the opportunity the association affords to repeat the last word of discovery to the people. A wide variety of societies for the promotion of this aim or the suppression of that evil have done well to follow the association's lead in one or two directions. First, in hospitality to all in sympathy with the object sought to be furthered, without asking the candidate for membership what he knows or what he has done. Of course, societies for advanced study, such as the Societies of Morphologists and Anatomists, can not set before everybody this open door, but bodies for work less specialized find their account in creating honorary or associate memberships which broaden their foundations in public sympathy and support; especially is this result desirable where the research promoted is, let us say, astronomical, and bears in the market-place no price.

The American Association, too, has set a good example in migrating from place to place year by year, so as to kindle the widest possible interest. To cite a case where visits of this kind have borne fruit, Montreal has within the past ten years been enriched by benefactions for education which give her rank with the most highly favored cities of the continent. These foundations, and the local response to the opportunities they offer, are in no small measure traceable to the important scientific meetings held since 1881 in the Canadian metropolis. In Canada, as in the United States, there is much sound sentiment regarding the fast-disappearing woodland wealth. This sentiment is largely to be

credited to the American Forestry Association, a comparatively small body, which, in its peregrinations north and south, and east and west, has brought many thousands of people to its way of thinking, and with them not a few of their lawmakers. In 1891 Congress authorized the President to set apart as a reservation any public land wholly or in part covered with trees; in two years this law has recovered tracts aggregating twelve million acres. For the proper forestry administration of these and other lands of the Federal Government the association is the only organized means of agitation in the country. Perhaps one reason why the American Social Science Association does not exert the influence it merits is that its gatherings always take place in Saratoga; this, too, while its British prototype observes the rule of itineracy. Even the National Academy of Sciences, whose investigations are of the most recondite order, migrates for one of its semi-annual meetings. To take the example of an industrial organization that keeps to the road let the National Electric Light Association be named: its tours throughout the land serve to refresh men devoted to an arduous profession; in their examination, on these tours, of all kinds of electrical installations practice everywhere tends to rise to the level of the best; and wherever the association goes it gives a local stimulus to the interest in Nature's master force in all that it means for the relief of toil and the refinement of life. When an organization to promote science pure or applied is put on wheels another advantage arises: its visits to a chain of towns and cities rarely fail to bring out a good deal of amateur talent—confirming tastes and talents which do much to cheer their possessors amid the drudgery of office or shop. The trained inquirer may look askance at the amateur, but it is well to remember that Dr. William Huggins, the President of the British Association in 1891, an astronomer who has notably furthered the science and art of stellar spectroscopy, calls himself but an amateur; Mr. Thomas D. Anderson, of Edinburgh, another amateur, last year discovered the new star in Auriga so earnestly discussed as probably confirming the meteoritic hypothesis of stellar accretions; an amateur, too, it was who, in the person of James Prescott Joule, first ascertained the mechanical equivalent of heat, the basis of the doctrine of the conservation of energy. In no infrequent case an intellectual man of leisure, who has not yet formed habits of idleness, has had a genuine and lasting interest aroused by the advent of a learned or scientific society in his neighborhood.

While the advancement of science is the stated purpose of the American Association, it has accomplished much else that could ill have been spared. It has periodically brought together old friends whom the exigencies of professional or business careers

have separated by the breadth of great States or even by the width of America. Its social meetings have often been as gainful as delightful. Here the youth just across the threshold of geology or astronomy has met the veteran explorer or observer, and thenceforward his work has known the ardor of discipleship; there are men now eminent in American science who recall as among their first inspirations the noble and kindly faces of Henry, Gray, Guyot, and Agassiz at association meetings. There is always a good deal in the mind of a man of science that he does not care to commit to a formal report or a dignified text-book; his appraisals of the current literature of his special field, his suggestive criticisms of the latest audacities of theory, his shrewd guesses as to what next awaits the discoverer, are only for those who meet him face to face. Not seldom a thinker or an experimenter in a remote corner of the country cherishes a hypothesis or proposes an apparatus intended to solve an old difficulty in a new way. At an association meeting he finds the mechanician or the chemist, who of all men can best disabuse his mind of its harbored fallacy, or point out how for success his project must be modified. And many men prosecute masterly work at lonely outposts, or, worse still, in populous centers of uninterested people; they are spared a withering sense of isolation in finding at the yearly muster that it is after all a goodly army in which they are enlisted. In so far, too, as the association has managed to keep specialists of eminence in its ranks, they receive at the annual assemblies not less benefit than the tyros. The observer with microscopic slides or test-tubes constantly at his eye is refreshed when he meets at the council table and the general session his peer of the geologic hammer or the telescope. Nor must the benefits be forgotten which the association has conferred upon men of affairs drawn into its audiences and interested in its work. They have seen somewhat of the unselfish labor in breaking new ground which must go before the sowing and reaping we know as industry and business. Hence have arisen generous gifts for research—which might well be multiplied; and, apart from any question into which gain or gift can enter, the association has done noble work in bringing to the people a glimpse, at least, of that inspiring ray which ever gilds truth as it emerges from the unknown.

Much that can be said of the good born of this association's meetings is true of those of many societies for research, education, or reform, which year by year and almost month by month spring into existence. Let us glance at one or two cases where a small band of earnest men have been able to do great things, not for science, but for righteousness. The Civil-service Reform Association, founded by George William Curtis and his friends

in 1881, has in its agitation of twelve years been the chief agency at work in combating the claim that "to the victor belong the spoils." To-day one fourth the offices in the gift of the Federal Government are subject to reform rules, with promise that at no distant day "the aristocracy of 'pull' shall make way for the democracy of merit." Mr. Curtis and Mr. Schurz, in their stirring addresses from the chair of the association, have reached audiences a thousandfold greater than those within sound of their voices; the press has made the Rocky Mountains their back benches. Against another iniquity battle was waged, in 1883, when the Copyright League took form. The league began as a handful of men, few of them rich or influential, attacking a compact and well-armed pirate crew and a solid mass of unsound public sentiment. Within eight years the people were brought to preferring to a cheap book a book honestly come by, Congress passing a bill declaring that literary property is property still, even when a foreigner creates it. The league in its series of authors' readings given in the principal cities of the Union had a magnet of uncommon power, evoking vastly more interest in the cause of international justice than any set arguments could have done. It is only fair to say that the agitation which the league inherited dated back to 1837; it may be worth while to add that the money cost of the league's work was but ten thousand dollars.

Not the least of the attractions which Chicago offers her visitors this year is her programme of congresses. Associations educational, industrial, scientific, and philosophical are assembling in the Western metropolis in rapid succession and under circumstances in which the art of their management can easily be carried a step further than in any past achievement in America. The local committees for the reception of visiting bodies will have more or less permanence, and will therefore through experience grow proficient, an exceptionally large number of the well informed and inquiring can be drawn upon from the throngs attending the fair, and the manifold departments of the exhibition will furnish in profusion illustrative material of rare quality. Hon. C. C. Bonney, chairman of the World's Congress Auxiliary, is in permanent charge of the congresses convened during the Columbian Exposition. He supervises the working details of each special committee; and his chief aim in his work is that relations among the leaders of thought and action which hitherto have been only local, shall henceforth become international.

To those whose duty it is to attend meetings, scientific and other, remarkable contrasts in their management are familiar. The success of a meeting is earned only by a business-like control, which makes thorough preparation months beforehand. The

executive board, by whatever name it may be called, should be a body of competent, resourceful, and hard-working men. Their main task is to insure good addresses and papers; however little of a speechmaker a man may be, he always talks willingly and acceptably on a subject he has mastered and which is dear to his heart; for papers a selection is usually feasible from manuscripts voluntarily offered, but it is ever found that the one way to have interesting themes treated by the busy people who have a first-hand knowledge of them is by tactful and timely solicitation.

How grievously have audiences, learned and unlearned, suffered from the coarseness of the sieve through which papers are commonly sifted! At the Toronto meeting of the American Association, in 1889, I heard a paper which, admittedly, had been published five years before. It is a case all too frequent that a paper is prolix or trivial, or covers ground thoroughly familiar, or that its writer imagines dilution to be simplification. A very ordinary offense is the technical description or argument which wears its bones outside and spares its victims no jot of anatomical detail. In securing contributions of high value the American Economical Association sets a shining example. Jointly with the International Statistical Institute it will hold sessions in Chicago from September 9th to 16th; all the principal papers were arranged for months ago by the committee in charge. When a writer is in this way given abundant time to prepare his manuscript he can do justice to the public and to himself; he has opportunity to secure publication in an appropriate journal or review, an important point to people who have only their pens to live by. The presidents of the American Association for the Advancement of Science are chosen two years and the presidents of its sections one year before the delivery of their addresses; with this ample time for elaboration and revision contributions to scientific literature of the highest rank have been secured. At the Boston meeting of 1880, the most interesting ever held by the association, Prof. George F. Barker gave his address on Modern Aspects of the Life Question, a luminous summary of progress in physical, physiological, and psychological science, which, enriched with its numerous references, can still serve the student as a guide post. Prof. S. P. Langley, at Cleveland in 1888, outlined in masterly fashion the history of the doctrine of radiant energy. Two years later, at Indianapolis, Dr. Frank Baker traced The Ascent of Man in an address which is a model scientific statement made plain and clear. While its addresses from the chair have usually been excellent, in providing popular lectures the association has left much to be desired. Here it has a good deal to learn from its British namesake, which well understands how a discourse, by interesting the community visited as well as

the visitors, can in some degree requite the debt of hospitality. In their main outlines the conquests of science, in the hands of a skilled exponent, never fail to awaken the enthusiasm of popular audiences. To the essential democracy of the sympathies of research, conceived on broad lines, let the thousands testify who have seen Prof. E. S. Morse at the blackboard busy with both hands tracing the development of birds from reptilian forms, or Prof. E. E. Barnard, of Lick Observatory, as he has thrown on the screen images of myriad stars seized in new spheres of space only through the exquisitely sensitive and tireless eye of the camera.

There is sound policy as well as justice in the sedulous cultivation of points of contact between every-day interests and the highly specialized work which only remotely may issue in a utility. A chemist may be enabled to experiment on di-nitro-sulphophenol, and publish his results, because an intelligent manufacturer has through the labor of chemists found a market for coal-tar products, or furnace slag, once thrown away. The links between science pure and applied might well receive more illustration at scientific gatherings than they commonly do. In carefully maintaining its features of popular instruction in this and other respects, the British Association has done much to win its long-sustained pre-eminence. To what else can that primacy be attributed? To its continuity of work and supervision the year round. Its committees, some fifty in number, are charged with investigations, botanical, zoölogical, and other; they confer as to standards of measurement and establish them; they ascertain the properties of solutions, or consider electrolysis in its physical and chemical bearings. All this labor is constantly enrolling new workers, and enabling the officers to appraise the talents and availability of workers new and old. At the meetings he must be a specialist indeed who does not find his particular study illuminated in the committee reports.

Be the object of a society what it may, on the programme of a meeting the main items, of course, are the addresses and papers. When by seasonable solicitation these latter are in hand, printed copies of them, subject to revision, can be distributed prior to their being formally offered. This plan, adopted by the American Institute of Mining Engineers and a few other organizations, should become general. It saves time at a session, where only abstracts need be presented; or, where the writer of a paper can instead of an abstract, give in an extemporaneous word the gist of his manuscript, the printing a paper in advance gives those who are interested in its subject the information needful for comment and criticism. Discussion is of the very essence of a meeting's value, and the institute just named always endeavors

that engineers of mark shall offer their opinions on the papers presented. In the planning of such discussion lies a way of escape from the narrowness and sterility which ever threaten specialization in its modern extremes.

It has often been suggested that some broad question, as the probable age of the earth, be considered at a joint meeting of all the sections of the American Association. Physicists, geologists, and naturalists vary by millions of years in their estimates of the length of our planet's life. The surveys of the special sciences into which, for convenience' sake, inquiry here is parceled out, plainly do not fit together as the parts of an accordant map. Clearly there is need of more light, of exploration of intervening and debatable territory, of new and reconciling generalization. It is in its untraversed border lands, rather than in its measured and cultivated areas, that science has promise and inspiration for the investigator. Discussions are difficult to arrange, and in the ordinary case are unsatisfactory, but in overcoming the obstacles to assigning the specialist a part in the orchestration of high inquiry is rescue from the danger that in the minute study of details their value in constructive thought, in mutual illumination, may be forgotten. At this point re-enters, too, the ever desirable feasibility of interesting the general public, of making the people feel that here and there stand open doors between the questions which come home to them and the fields tilled by men of research.

This matter of interesting the public can at times find its opportunity when the programme is elastic enough to admit the treatment of a question of moment which springs up after the programme has taken form. Last August the American Economic Association met at Chautauqua; most of those who took part in its sessions passed at Buffalo through files of State militia guarding the trains against strikers and rioters. The programme, an excellent one, from the inevitable absence of men expected to read papers, could not be fully carried out. Here was a chance for leading teachers in politics and economics to express themselves regarding a battle between capital and labor pitched in the very neighborhood; outside the session hall, scarcely anything else was talked about; within the hall, Buffalo might have been in Asia for all the attention it received. Can men of science of the academic type wonder at their lack of popular influence when they thus ignore the world of action and passion they live in; when they speak and write mainly at one another, and usually in a language hardly comprehensible to common people when they happen to overhear it? It strikes observers in New York that the power of its corrupt rulers has arisen in no small degree because the leaders among them have been fortunate or shrewd

enough to share the every-day interests of every-day people. Whether from limitation or choice, no sachem of Tammany is ever so far ahead of his followers as to be hidden from them by the curvature of the earth. A teacher of political economy in a leading American university declares that the man politically most influential in this country is the bar-tender; if so, what political text-book or society for political instruction has ever reckoned with him?

A few of the more noteworthy organizations which meet statedly, publish their discussions as well as their papers—a praiseworthy and useful thing to do. This plan is adopted by the American Library Association, a body which renders invaluable service to public libraries, and hence to popular education. The papers to be read at its next meeting, at Chicago, July 13th to 22d, have been assigned to representative men and women in such wise that published as a volume they will form a complete handbook of library economy. This introduction of a comprehensive purpose in gathering contributions that otherwise might be disconnected and desultory is an idea well worth transplanting wherever admissible. The Library Association owes its origin and success in large measure to a secretary of uncommon ability and energy, fertile in ideas and indefatigable in giving them effect. This year he is president. An efficient executive officer is indispensable in arranging the details for a successful meeting. With the principal papers and discussions arranged for, he pays a preliminary visit to the place of meeting. He makes sure that the sessional halls are convenient, ample, and suitably furnished and served; that, if need be, stereopticon views can be properly shown, and that hotel and other quarters are in readiness. He confers with the reception committee, whom he finds not only willing but anxious that out of the fullness of his experience of shortcomings he shall freely speak. He sees that the printed matter of his association is put where people can get it. If, as the civil-service reformers do, he distributes a "primer," it does not fail to say how one can join the organization that sent it forth. He cooperates with the local press in telling the community what people of eminence or note are coming, what they are eminent or notable for, and what they mean to read and discuss. Aided by having the principal papers in print, when the meeting takes place he is enabled to insure fullness, or at least correctness, in the press reports of sessions, remembering that many more will read these reports than can come to session halls. Each day, as early as he can, he takes pains to send to the newspapers the next day's programme. He engages a stenographer to take down the discussions; they may not be published, but they are worth keeping on record, if for no other reason than that they show

how hard it is to get a new idea into people's heads. In brief, this officer is as zealous in attracting audiences, in arousing communities, in promoting the aims of his society, as if he were a man of business creating a market for profitable wares, or a missionary spreading gospel light. Let us note a case or two where the lack of such an officer in the receiving or visiting body has been felt. At Rochester, last August, the American Association was tendered a reception in an art gallery on the upper floors of an office building. Its owner was in Europe, which doubtless accounted for the catalogues of the collection being not lent but sold to his guests, while a staring sign announcing, "To the steel tower—ten cents," was permitted to remain uncovered. At Rochester, too, a city famous for its nurseries, it never occurred to the local committee that visitors would be glad to see these nurseries. Their gates, of course, stood open, yet a very little trouble taken to provide informed guides at a stated time would have added much to the profit and pleasure of a visit. During the week of last Christmas the American Psychological Association met at the University of Pennsylvania. Its first session was held in an upper room of the main building, the second took place in another building some distance off. Because there was no public notification of this change of place, a score of members, teachers, and reporters wasted an afternoon, and missed the presidential address which three of them had come a hundred miles to hear. A few years ago the American Institute of Mining Engineers met at Lookout Mountain. One of the party was the late Thomas Sterry Hunt, an ex-president. In an address which could only come from a master in both chemistry and geology, he described the history of the region at his feet. As he spoke, the conclusions of many thoughtful years were compressed into his pithy sentences. Because he had prepared no notes, and because no stenographer was engaged, that masterly discourse is now only a fading memory.

M. LIONEL DÉCLE, who has lately returned from the Zambesi region in Central Africa, recently visited the underground lake of Sinoie. He describes it as presenting one of the most wonderful specimens which can be given to man to contemplate on the globe. The water is remarkably blue, far more so than that of the blue grottoes of Capri.

GIVING his personal and political reminiscences in a recent address, Sir John Lubbock said that he took the first photograph (rather daguerreotype) ever taken in England. Daguerre was a great friend of his father's, and, when he had completed the invention, sent him over a lens with complete apparatus. Sir John, who was then a very small child, was told to remove the cap, and, doing so, achieved the feat.

PROFESSOR WEISMANN'S THEORIES.*

By HERBERT SPENCER.

APART from those more special theories of Prof. Weismann I lately dealt with, the wide acceptance of which by the biological world greatly surprises me, there are certain more general theories of his—fundamental theories—the acceptance of which surprises me still more. Of the two on which rests the vast superstructure of his speculation, the first concerns the distinction between the reproductive elements of each organism and the non-reproductive elements. He says:

"Let us now consider how it happened that the multicellular animals and plants, which arose from unicellular forms of life, came to lose this power of living forever.

"The answer to this question is closely bound up with the principle of division of labor which appeared among multicellular organisms at a very early stage. . . .

"The first multicellular organism was probably a cluster of similar cells, but these units soon lost their original homogeneity. As the result of mere relative position, some of the cells were especially fitted to provide for the nutrition of the colony, while others undertook the work of reproduction" (Essays upon Heredity, p. 27).

Here, then, we have the great principle of the division of labor, which is the principle of all organization, taken as primarily illustrated in the division between the reproductive cells and the non-reproductive or somatic cells—the cells devoted to the continuance of the species, and the cells which subserve the life of the individual. And the early separation of reproductive cells from somatic cells, is alleged on the ground that this primary division of labor is that which arises between elements devoted to species-life and elements devoted to individual life. Let us not be content with words but look at the facts.

When Milne-Edwards first used the phrase "physiological division of labor," he was obviously led to do so by perceiving the analogy between the division of labor in a society, as described by political economists, and the division of labor in an organism. Every one who reads has been familiarized with the first as illustrated in the early stages, when men were warriors while the cultivation and drudgery were done by slaves and women; and as illustrated in the later stages, when not only are agriculture and manufactures carried on by separate classes, but agriculture is carried on by landlords, farmers, and laborers, while manufactures, multitudinous in their kinds, severally involve the actions

* A postscript to the essay on The Inadequacy of "Natural Selection."

of capitalists, overseers, workers, etc., and while the great function of distribution is carried on by wholesale and retail dealers in different commodities. Meanwhile students of biology, led by Milne-Edwards's phrase, have come to recognize a parallel arrangement in a living creature; shown, primarily, in the devoting of the outer parts to the general business of obtaining food and escaping from enemies, while the inner parts are devoted to the utilization of food and supporting themselves and the outer parts; and shown, secondarily, by the subdivision of these great functions into those of various limbs and senses in the one case, and in the other case into those of organs for digestion, respiration, circulation, excretion, etc. But now let us ask what is the essential nature of this division of labor. In both cases it is an *exchange of services*—an arrangement under which, while one part devotes itself to one kind of action and yields benefit to all the rest, all the rest, jointly and severally performing their special actions, yield benefits to it in exchange. Otherwise described, it is a system of *mutual* dependence: A depends for its welfare upon B, C, and D; B upon A, C, and D, and so with the rest: all depend upon each and each upon all. Now let us apply this true conception of the division of labor to that which Prof. Weismann calls a division of labor. Where is the *exchange of services* between somatic cells and reproductive cells? There is none. The somatic cells render great services to the reproductive cells, by furnishing them with materials for growth and multiplication; but the reproductive cells render no services at all to the somatic cells. If we look for the *mutual* dependence we look in vain. We find entire dependence on the one side and none on the other. Between the parts devoted to individual life and the part devoted to species-life, there is no division of labor whatever. The individual works for the species; but the species works not for the individual. Whether at the stage when the species is represented by reproductive cells, or at the stage when it is represented by eggs, or at the stage when it is represented by young, the parent does everything for it, and it does nothing for the parent. The essential part of the conception is gone: there is no giving and receiving, no exchange, no mutuality.

But now suppose we pass over this fallacious interpretation, and grant Prof. Weismann his fundamental assumption and his fundamental corollary. Suppose we grant that because the primary division of labor is that between somatic cells and reproductive cells, these two groups are the first to be differentiated. Having granted this corollary, let us compare it with the facts. As the alleged primary division of labor is universal, so the alleged primary differentiation should be universal too. Let us see whether it is so. Already, in the paragraph from which I

have quoted above, a crack in the doctrine is admitted: it is said that "this differentiation was not at first absolute, and indeed it is not always so to-day." And then, on turning to page 74, we find that the crack has become a chasm. Of the reproductive cells it is stated that—"In Vertebrata they do not become distinct from the other cells of the body until the embryo is completely formed." That is to say, in this large and most important division of the animal kingdom, the implied universal law does not hold. Much more than this is confessed. Lower down the page we read —"There may be in fact cases in which such separation does not take place until after the animal is completely formed, and others, as I believe that I have shown, in which it first arises one or more generations later, viz., in the buds produced by the parent."

So that in other great divisions of the animal kingdom the alleged law is broken; as among the *Cœlenterata* by the Hydrozoa, as among the *Mollusca* by the Ascidians, and as among the *Annuloida* by the Trematode worms.

Even in ordinary life, a man whose supposition proves to be flatly contradicted by observation, is expected to hesitate; though, unhappily, he very often does not. But in the world of science, one who finds his hypothesis at variance with large parts of the evidence, forthwith abandons it. Not so Prof. Weismann. If he does not say with the speculative Frenchman, "*tant pis pour les faits*," he practically says something equivalent:—Propound your hypothesis; compare it with the facts; and if the facts do not agree with it, then assume potential fulfillment where you see no actual fulfillment. For this is what he does. Following his admission above quoted, concerning the Vertebrata, come certain sentences which I partially italicize:

"Thus, as their development shows, a marked antithesis exists between the substance of the undying reproductive cells and that of the perishable body-cells. We can not explain this fact except *by the supposition* that each reproductive cell potentially contains two kinds of substance, which at a variable time after the commencement of embryonic development, separate from one another, and finally produce two sharply contrasted groups of cells" (p. 74).

And a little lower down the page we meet with the lines:

"*It is therefore quite conceivable* that the reproductive cells might separate from the somatic cells much later than in the examples mentioned above, without changing the hereditary tendencies of which they are the bearers."

That is to say, it is "quite conceivable" that after sexless *Cercariæ* have gone on multiplying by internal gemmation for generations, the "two kinds of substance" have, notwithstanding innumerable cell-divisions, preserved their respective natures, and finally separate in such ways as to produce reproductive cells. Here Prof. Weismann does not, as in a case before noted, assume

something which it is "easy to imagine," but he assumes something which it is difficult to imagine; and apparently thinks that a scientific conclusion may be thereupon safely based.

But now to what end are we asked to make a gratuitous "supposition," to accept as true something strange which is "quite conceivable," and to strain our imaginations without the slightest aid from the evidence? Simply to save Prof. Weismann's hypothesis—to shelter it against a great body of adverse facts. When we have recognized the truth that what he regards as a primary division of labor is no division of labor at all—when we see that the corollary he draws respecting the implied primary differentiation of reproductive cells from somatic cells is consequently without warrant; we have no occasion to feel troubled that his deductive conclusion is inductively disproved. We are not dismayed on finding that throughout vast groups of organisms there is shown no such antithesis as his theory requires. And we need not do violence to our thoughts in explaining away the contradictions.

Associated with the assertion that the primary division of labor is between the somatic cells and the reproductive cells, and associated with the corollary that the primary differentiation is that which arises between them, there goes another corollary. It is alleged that there exists a fundamental distinction of nature between these two classes of cells. They are described as respectively mortal and immortal, in the sense that those of the one class are limited in their powers of multiplication, while those of the other class are unlimited. And it is contended that this is due to inherent unlikeness of nature.

Before inquiring into the truth of this proposition, I may fitly remark upon a preliminary proposition set down by Prof. Weismann. Referring to the hypothesis that death depends "upon causes which lie in the nature of life itself," he says:

> "I do not however believe in the validity of this explanation; I consider that death is not a primary necessity, but that it has been secondarily acquired as an adaptation. I believe that life is endowed with a fixed duration, not because it is contrary to its nature to be unlimited, but because the unlimited existence of individuals would be a luxury without any corresponding advantage" (p. 24).

This last sentence has a teleological sound which would be appropriate did it come from a theologian, but which seems strange as coming from a man of science. Assuming, however, that the implication was not intended, I go on to remark that Prof. Weismann has apparently overlooked a universal law of evolution—not organic only, but inorganic and superorganic—which implies the necessity of death. The changes of every aggre-

gate, no matter of what kind, inevitably end in a state of equilibrium. Suns and planets die, as well as organisms. The process of integration, which constitutes the fundamental trait of all evolution, continues until it has brought about a state which negatives further alterations, molar or molecular—a state of balance among the forces of the aggregate and the forces which oppose them.* In so far, therefore, as Prof. Weismann's conclusions imply the non-necessity of death, they can not be sustained.

But now let us consider the above-described antithesis between the immortal *Protozoa* and the mortal *Metazoa*. An essential part of the theory is that the *Protozoa* can go on dividing and subdividing without limit, so long as the fit external conditions are maintained. But what is the evidence for this? Even by Prof. Weismann's own admission there is no proof. On page 285 he says:

"I could only consent to adopt the hypothesis of rejuvenescence [achieved by conjugation] if it were rendered absolutely certain that reproduction by division could never under any circumstances persist indefinitely. But this can not be proved with any greater certainty than the converse proposition, and hence, as far as direct proof is concerned, the facts are equally uncertain on both sides."

But this is an admission which seems to be entirely ignored when there is alleged the contrast between the immortal *Protozoa* and the mortal *Metazoa*. Following Prof. Weismann's method, it would be "easy to imagine" that occasional conjugation is in all cases essential; and this easily imagined conclusion might fitly be used to bar out his own. Indeed, considering how commonly conjugation is observed, it may be held difficult to imagine that it can in any cases be dispensed with. Apart from imaginations of either kind, however, here is an acknowledgment that the immortality of *Protozoa* is not proved; that the allegation has no better basis than the failure to observe cessation of fission; and that thus one term of the above antithesis is not a fact, it is only an assumption.

But now what about the other term of the antithesis—the alleged inherent mortality of the somatic cells? This we shall, I think, find is no more defensible than the other. Such plausibility as it possesses disappears when, instead of contemplating the vast assemblage of familiar cases which animals present, we contemplate certain less familiar and unfamiliar cases. By these we are shown that the usual ending of multiplication among somatic cells is due not to an intrinsic cause, but to extrinsic causes. Let us, however, first look at Prof. Weismann's own statements:

"I have endeavored to explain death as the result of restriction in the powers of reproduction possessed by the somatic cells, and I have suggested that such

* See First Principles, part ii, chap. xxii, Equilibration.

restriction may conceivably follow from a limitation in the number of cell-generations possible for the cells of each organ and tissue" (p. 28).

"The above-mentioned considerations show us that the degree of reproductive activity present in the tissues is regulated by internal causes while the natural death of an organism is the termination—the hereditary limitation—of the process of cell-division, which began in the segmentation of the ovum" (p. 30).

Now though in the above extracts there is mention of "internal causes" determining "the degree of reproductive activity" of tissue cells, and though, on page 28, the "causes of the loss" of the power of unlimited cell-production "must be sought outside the organism, that is to say, in the external conditions of life"; yet the doctrine is that somatic cells have become constitutionally unfitted for continued cell-multiplication.

"The somatic cells have lost this power to a gradually increasing extent, so that at length they became restricted to a fixed, though perhaps very large, number of cell-generations" (p. 28).

Examination will soon disclose good reasons for denying this inherent restriction. We will look at the various causes which affect their multiplication and usually put a stop to increase after a certain point is reached.

There is first the amount of vital capital given by the parent; partly in the shape of a more or less developed structure, and partly in the shape of bequeathed nutriment. Where this vital capital is small, and the young creature, forthwith obliged to carry on physiological business for itself, has to expend effort in obtaining materials for daily consumption as well as for growth, a rigid restraint is put on that cell-multiplication required for a large size. Clearly the young elephant, starting with a big and well-organized body, and supplied *gratis* with milk during early stages of growth, can begin physiological business on his own account on a great scale; and by its large transactions his system is enabled to supply nutriment to its multiplying somatic cells until they have formed a vast aggregate—an aggregate such as it is impossible for a young mouse to reach, obliged as it is to begin physiological business in a small way. Then there is the character of the food in respect of its digestibility and its nutritiveness. Here, that which the creature takes in requires much grinding-up, or, when duly prepared, contains but a small amount of available matter in comparison with the matter that has to be thrown away; while there, the prey seized is almost pure nutriment, and requires but little trituration. Hence, in some cases, an unprofitable physiological business, and in other cases a profitable one; resulting in small or large supplies to the multiplying somatic cells. Further, there has to be noted the grade of visceral development, which, if low, yields only crude nutriment slowly distributed, but which, if high, serves by its good appli-

ances for solution, depuration, absorption, and circulation, to yield to the multiplying somatic cells a rich and pure blood. Then we come to an all-important factor, the cost of securing food. Here large expenditure of energy in locomotion is necessitated, and there but little—here great efforts for small portions of food, and there small efforts for great portions: again resulting in physiological poverty or physiological wealth. Next, beyond the cost of nervo-muscular activities in foraging, there is the cost of maintaining bodily heat. So much heat implies so much consumed nutriment, and the loss by radiation or conduction, which has perpetually to be made good, varies according to many circumstances—climate, medium (as air or water), covering, size of body (small cooling relatively faster than large); and in proportion to the cost of maintaining heat is the abstraction from the supplies for cell-formation. Finally, there are three all-important co-operative factors, or rather laws of factors, the effects of which vary with the size of the animal. The first is that, while the mass of the body varies as the cubes of its dimensions (*proportions* being supposed constant), the absorbing surface varies as the squares of its dimensions; whence it results that, other things equal, increase of size implies relative decrease of nutrition, and therefore increased obstacles to cell-multiplication.* The second is a further sequence from these laws—namely, that while the weight of the body increases as the cubes of the dimensions, the sectional areas of its muscles and bones increase as their squares; whence follows a decreasing power of resisting strains, and a relative weakness of structure. This is implied in the ability of a small animal to leap many times its own length, while a great animal, like the elephant, can not leap at all: its bones and muscles being unable to bear the stress which would be required to propel its body through the air. What increasing cost of keeping together the bodily fabric is thus entailed, we can not say; but that there is an increasing cost, which diminishes the available materials for increase of size, in beyond question.† And then, in the third place, we have augmented expense of distribution of nutriment. The greater the size becomes, the more force must be exerted to send blood to the periphery; and this once more entails deduction from the cell-forming matters.

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* Principles of Biology, § 46 (No. 8, April, 1863).

† Ibid. This must not be understood as implying that while the mass increases as the cubes, the *quantity of motion* which can be generated increases only as the squares; for this would not be true. The quantity of motion is obviously measured, not by the sectioned areas of the muscles alone, but by these multiplied into their lengths, and therefore increases as the cubes. But this admission leaves untouched the conclusion that the ability to *bear stress* increases only as the squares, and thus limits the ability to generate motion, by relative incoherence of materials.

Here, then, we have nine factors, several of them involving subdivisions, which co-operate in aiding or restraining cell-multiplication. They occur in endlessly varied proportions and combinations; so that every species differs more or less from every other in respect of their effects. But in all of them the co-operation is such as eventually arrests that multiplication of cells which causes further growth; continues thereafter to entail slow decrease in cell-multiplication, accompanying decline of vital activities; and eventually brings cell-multiplication to an end. Now a recognized principle of reasoning—the Law of Parsimony—forbids the assumption of more causes than are needful for explanation of phenomena; and since, in all such living aggregates as those above supposed, the causes named inevitably bring about arrest of cell-multiplication, it is illegitimate to ascribe this arrest to some inherent property in the cells. Inadequacy of the other causes must be shown before an inherent property can be rightly assumed.

For this conclusion we find ample justification when we contemplate types of animals which lead lives that do not put such decided restraints on cell-multiplication. First let us take an instance of the extent to which (irrespective of the natures of cells as reproductive or somatic) cell-multiplication may go where the conditions render nutrition easy and reduce expenditure to a minimum. I refer to the case of the *Aphides*. Though it is early in the season (March), the hothouses at Kew have furnished a sufficient number of these to show that twelve of them weigh a grain —a larger number than would be required were they full-sized. Citing Prof. Owen, who adopts the calculations of Tougard to the effect that by agamic multiplication "a single impregnated ovum of *Aphis* may give rise, without fecundation, to a quintillion of *Aphides*," Prof. Huxley says:

"I will assume that an Aphis weighs $\frac{1}{1000}$ of a grain, which is certainly vastly under the mark. A quintillion of *Aphides* will, on this estimate, weigh a quatrillion of grains. He is a very stout man who weighs two million grains; consequently the tenth brood alone, if all its members survive the perils to which they are exposed, contains more substance than 500,000,000 stout men—to say the least, more than the whole population of China!"*

And had Prof. Huxley taken the actual weight, one twelfth of a grain, the quintillion of *Aphides* would evidently far outweigh the whole human population of the globe: five billions of tons being the weight as brought out by my own calculation! Of course I do not cite this in proof of the extent to which multipli-

* The Transactions of the Linnæan Society of London, vol. xxii, p. 215. The estimate of Réaumur, cited by Kirby and Spence, is still higher—"In five generations one Aphis may be the progenitor of 5,904,900,000 descendants; and it is supposed that in one year there may be twenty generations" (Introduction to Entomology, vol. i, p. 175).

cation of somatic cells, descending from a single ovum, may go; because it will be contended, with some reason, that each of the sexless *Aphides*, viviparously produced, arose by fission of a cell which had descended from the original reproductive cell. I cite it merely to show that when the cell-products of a fertilized ovum are perpetually divided and subdivided into small groups distributed over an unlimited nutritive area, so that they can get materials for growth at no cost, and expend nothing appreciable in motion or maintenance of temperature, cell-production may go on without limit. For the agamic multiplication of *Aphides* has been shown to continue for four years, and to all appearance would be ceaseless were the temperature and supply of food continued without break. But now let us pass to analogous illustrations of cause and consequence open to no criticism of the kind just indicated. They are furnished by various kinds of *Entozoa*, of which take the *Trematoda* infesting mollusks and fishes. Of one of them we read: "*Gyrodactylus* multiplies agamically by the development of a young Trematode within the body, as a sort of internal bud. A second generation appears within the first, and even a third within the second, before the young *Gyrodactylus* is born."* And the drawings of Steenstrup, in his Alternation of Generations, show us, among creatures of this group, a sexless individual, the whole interior of which is transformed into smaller sexless individuals, which severally, before or after their emergence, undergo similar transformations—a multiplication of somatic cells without any sign of reproductive cells. Under what circumstances do such modes of agamic multiplication, variously modified among parasites, occur? They occur where there is no expenditure whatever in motion or maintenance of temperature, and where nutriment surrounds the body on all sides. Other instances are furnished by groups in which, though the nutrition is not abundant, the cost of living is almost unappreciable. Among the *Cœlenterata* there are the Hydroid Polyps, simple and compound; and among the *Mollusca* we have various types of Ascidians, fixed and floating, *Botryllidæ* and *Salpæ*.

But now from these low animals, in which sexless reproduction, and continued multiplication of somatic cells, is common, and one class of which is named "zoöphytes," because its form of life simulates that of plants, let us pass to plants themselves. In these there is no expenditure in effort, there is no expenditure in maintaining temperature, and the food, some of it supplied by the earth, is the rest of it supplied by a medium which everywhere bathes the outer surface: the utilization of its contained material being effected *gratis* by the sun's rays. Just as was to be ex-

* A Manual of the Anatomy of Invertebrated Animals, by T. H. Huxley, p. 206.

pected, we here find that agamogenesis may go on without end. Numerous plants and trees are propagated to an unlimited extent by cuttings and buds; and we have sundry plants which can not be otherwise propagated. The most familiar are the double roses of our gardens: these do not seed, and yet have been distributed everywhere by grafts and buds. Hothouses furnish many cases, as I learn from an authority second to none. Of "the whole host of tropical orchids, for instance, not one per cent has ever seeded, and some have been a century under cultivation." Again, we have the *Acorus calamus*, "that has hardly been known to seed anywhere, though it is found wild all over the north temperate hemisphere." And then there is the conspicuous and conclusive case of *Eloidea Canadensis* (alias *Anacharis*) introduced no one knows how (probably with timber), and first observed in 1847, in several places; and which, having since spread over nearly all England, now everywhere infests ponds, canals, and small slow rivers. The plant is dicœcious, and only the female exists here. Beyond all question, therefore, this vast progeny of the first slip or fragment introduced, now sufficient to cover many square miles were it put together, is constituted entirely of somatic cells; and this cell-multiplication, and consequent plant-growth, show no signs of decrease. Hence, as far as we can judge, these somatic cells are immortal in the sense given to the word by Prof. Weismann; and the evidence that they are so is immeasurably stronger than the evidence which leads him to assert immortality for the fissiparously-multiplying *Protozoa*. This endless multiplication of somatic cells has been going on under the eyes of numerous observers for forty odd years. What observer has watched for forty years to see whether the fissiparous multiplication of *Protozoa* does not cease? What observer has watched for one year, or one month, or one week?

Even were not Prof. Weismann's theory disposed of by this evidence, it might be disposed of by a critical examination of his own evidence, using his own tests. Clearly, if we are to measure relative mortalities, we must assume the conditions the same and must use the same measure. Let us do this with some appropriate animal—say Man, as the most open to observation. The mortality of the somatic cells constituting the mass of the human body is, according to Prof. Weismann, shown by the decline and final cessation of cell-multiplication in its various organs. Suppose we apply this test to all the organs: not to those only in which there continually arise bile-cells, epithelium-cells, etc., but to those also in which there arise reproductive cells. What do we find? That the multiplication of these last comes to an end long before the multiplication of the first. In a healthy woman, the cells which constitute the various active tissues of the body continue to grow

and multiply for many years after germ-cells have died out. If similarly measured, then, these cells of the last class prove to be more mortal than those of the first. But Prof. Weismann uses a different measure for the two classes of cells. Passing over the illegitimacy of this proceeding, let us accept his other mode of measurement, and see what comes of it. As described by him, absence of death among the *Protozoa* is implied by that unceasing division and subdivision of which they are said to be capable. Fission continued without end, is the definition of the immortality he speaks of. Apply this conception to the reproductive cells in a *Metazoon*. That the immense majority of them do not multiply without end we have already seen: with very rare exceptions they die and disappear without result, and they cease their multiplication while the body as a whole still lives. But what of those extremely exceptional ones which, as being actually instrumental to the maintenance of the species, are alone contemplated by Prof. Weismann? Do these continue their fissiparous multiplications without end? By no means. The condition under which alone they preserve a qualified form of existence, is that, instead of one becoming two, two become one. A member of series A and a member of series B coalesce, and so lose their individualities. Now, obviously, if the immortality of a series is shown if its members divide and subdivide perpetually, then the opposite of immortality is shown when, instead of division, there is union. Each series ends, and there is initiated a new series, differing more or less from both. Thus the assertion that the reproductive cells are immortal, can be defended only by changing the conception of immortality otherwise implied.

Even apart from these last criticisms, however, we have clear disproof of the alleged inherent difference between the two classes of cells. Among animals the multiplication of somatic cells is brought to an end by sundry restraining conditions; but in various plants, where these restraining conditions are absent, the multiplication is unlimited. It may, indeed, be said that the alleged distinction should be reversed; since the fissiparous multiplication of reproductive cells is necessarily interrupted from time to time by coalescence, while that of the somatic cells may go on for a century without being interrupted.

In the essay to which this is a postscript, conclusions were drawn from the remarkable case of the horse and quagga there narrated, along with an analogous case observed among pigs. These conclusions have since been confirmed. I am much indebted to a distinguished correspondent who has drawn my attention to verifying facts furnished by the offspring of whites and negroes in the United States. Referring to information given him many

years ago, he says: "It was to the effect that the children of white women by a white father had been *repeatedly* observed to show traces of black blood, in cases when the woman had previous connection with [i. e., a child by] a negro." At the time I received this information, an American was visiting me; and, on being appealed to, answered that in the United States there was an established belief to this effect. Not wishing, however, to depend upon hearsay, I at once wrote to America to make inquiries. Prof. Cope, of Philadelphia, has written to friends in the South, but has not yet sent me the results. Prof. Marsh, the distinguished paleontologist, of Yale, New Haven, who is also collecting evidence, sends a preliminary letter in which he says: "I do not myself know of such a case, but have heard many statements that make their existence probable. One instance, in Connecticut, is vouched for so strongly by an acquaintance of mine, that I have good reason to believe it to be authentic."

That cases of the kind should not be frequently seen in the North, especially nowadays, is of course to be expected. The first of the above quotations refers to facts observed in the South during slavery days; and even then, the implied conditions were naturally very infrequent. Dr. W. J. Youmans, of New York, has, on my behalf, interviewed several medical professors, who, though they have not themselves met with instances, say that the alleged result, described above, "is generally accepted as a fact." But he gives me what I think must be regarded as authoritative testimony. It is a quotation from the standard work of Prof. Austin Flint, and runs as follows:

"A peculiar and, it seems to be, an inexplicable fact is, that previous pregnancies have an influence upon offspring. This is well known to breeders of animals. If pure-blooded mares or bitches have been once covered by an inferior male, in subsequent fecundations the young are likely to partake of the character of the first male, even if they be afterward bred with males of unimpeachable pedigree. What the mechanism of the influence of the first conception is, it is impossible to say; but the fact is incontestable. The same influence is observed in the human subject. A woman may have, by a second husband, children who resemble a former husband, and this is particularly well marked in certain instances by the color of the hair and eyes. A white woman who has had children by a negro may subsequently bear children to a white man, these children presenting some of the unmistakable peculiarities of the negro race."*

Dr. Youmans called on Prof. Flint, who remembered "investigating the subject at the time his larger work was written [the above is from an abridgment], and said that he had never heard the statement questioned."

Some days before I received this letter and its contained quo-

* A Text-Book of Human Physiology. By Austin Flint, M. D., LL. D. Fourth edition. New York: D. Appleton & Co., 1888, p. 797.

tation, the remembrance of a remark I heard many years ago concerning dogs, led to the inquiry whether they furnished analogous evidence. It occurred to me that a friend who is frequently appointed judge of animals at agricultural shows, Mr. Fookes, of Fairfield, Pewsey, Wiltshire, might know something about the matter. A letter to him brought various confirmatory statements. From one "who had bred dogs for many years" he learned that—

"It is a well-known and admitted fact that if a bitch has two litters by two different dogs, the character of the first father is sure to be perpetuated in any litters she may afterward have, no matter how pure-bred a dog may be the begetter."

After citing this testimony, Mr. Fookes goes on to give illustrations known to himself.

"A friend of mine near this had a very valuable Dachshund bitch, which most unfortunately had a litter by a stray sheep-dog. The next year her owner sent her on a visit to a pure Dachshund dog, but the produce took quite as much of the first father as the second, and the next year he sent her to another Dachshund with the same result. Another case: A friend of mine in Devizes had a litter of puppies, unsought for, by a setter from a favorite pointer bitch, and after this she never bred any true pointers, no matter of what the paternity was."

These further evidences, to which Mr. Fookes has since added others, render the general conclusion incontestable. Coming from remote places, from those who have no theory to support, and who are some of them astonished by the unexpected phenomena, the agreement dissipates all doubt. In four kinds of mammals, widely divergent in their natures—man, horse, dog, and pig—we have this same seemingly anomalous kind of heredity made visible under analogous conditions. We must take it as a demonstrated fact that, during gestation, traits of constitution inherited from the father produce effects upon the constitution of the mother; and that these communicated effects are transmitted by her to subsequent offspring. We are supplied with an absolute disproof of Prof. Weismann's doctrine that the reproductive cells are independent of, and uninfluenced by, the somatic cells; and there disappears absolutely the alleged obstacle to the transmission of acquired characters.

Notwithstanding experiences showing the futility of controversy for the establishment of truth, I am tempted here to answer opponents at some length. But even could the editor allow me the needful space, I should be compelled both by lack of time and by ill health to be brief. I must content myself with noticing a few points which most nearly concern me.

Referring to my argument respecting tactual discriminativeness, Mr. Wallace thinks that I—

"afford a glaring example of taking the unessential in place of the essential, and drawing conclusions from a partial and altogether insufficient survey of the phenomena. For this 'tactual discriminativeness,' which is alone dealt with by Mr. Spencer, forms the least important, and probably only an incidental portion of the great vital phenomenon of skin-sensitiveness, which is at once the watchman and the shield of the organism against imminent external dangers" (Fortnightly Review, April, 1893, p. 497).

Here Mr. Wallace assumes it to be self-evident that skin-sensitiveness is due to natural selection, and assumes that this must be admitted by me. He supposes it is only the unequal distribution of skin-discriminativeness which I contend is not thus accounted for. But I deny that either the general sensitiveness or the special sensitiveness results from natural selection; and I have years ago justified the first disbelief, as I have recently the second. In The Factors of Organic Evolution, pp. 66–70, I have given various reasons for inferring that the genesis of the nervous system can not be due to survival of the fittest; but that it is due to the direct effects of converse between the surface and the environment; and that thus only is to be explained the strange fact that the nervous centers are originally superficial, and migrate inward during development. These conclusions I have, in the essay Mr. Wallace criticises, upheld by the evidence which blind boys and skilled compositors furnish; proving, as this does, that increased nervous development is peripherally initiated. Mr. Wallace's belief that skin-sensitiveness arose by natural selection is unsupported by a single fact. He assumes that it *must* have been so produced because it is all-important to self-preservation. My belief that it is directly initiated by converse with the environment is supported by facts; and I have given proof that the assigned cause is now in operation. Am I called upon to abandon my own supported belief and accept Mr. Wallace's unsupported belief? I think not.

Referring to my argument concerning blind cave animals, Prof. Lankester, in Nature of February 3, 1893, writes:

"Mr. Spencer shows that the saving of ponderable material in the suppression of an eye is but a small economy: he loses sight of the fact, however, that possibly, or even probably, the saving of the organism in the reduction of an eye to a rudimentary state is not to be measured by mere bulk, but by the non-expenditure of special materials and special activities which are concerned in the production of an organ so peculiar and elaborate as is the vertebrate eye."

It seems to me that a supposition is here made to do duty as a fact; and that I might with equal propriety say that "possibly, or even probably," the vertebrate eye is physiologically cheap: its optical part, constituting nearly its whole bulk, consisting of a low order of tissue. There is, indeed, strong reason for considering it physiologically cheap. If any one remembers how relatively enormous are the eyes of a fish just out of the egg—a pair of eyes

with a body and head attached; and if he then remembers that every egg contains material for such a pair of eyes; he will see that eye-material constitutes a very considerable part of the fish's roe; and that, since the female fish provides this quantity every year, it can not be expensive. My argument against Weismann is strengthened rather than weakened by contemplation of these facts.

Prof. Lankester asks my attention to a hypothesis of his own, published in the Encyclopædia Britannica, concerning the production of blind cave-animals. He thinks it can—

"be fully explained by natural selection acting on congenital fortuitous variations. Many animals are thus born with distorted or defective eyes whose parents have not had their eyes submitted to any peculiar conditions. Supposing a number of some species of Arthropod or Fish to be swept into a cavern or to be carried from less to greater depths in the sea, those individuals with perfect eyes would follow the glimmer of light and eventually escape to the outer air or the shallower depths, leaving behind those with imperfect eyes to breed in the dark place. A natural selection would thus be effected" in successive generations.

First of all, I demur to the words "many animals." Under the abnormal conditions of domestication, congenitally defective eyes may be not very uncommon; but their occurrence under natural conditions is, I fancy, extremely rare. Supposing, however, that in a shoal of young fish, there occur some with eyes seriously defective. What will happen? Vision is all-important to the young fish, both for obtaining food and for escaping from enemies. This is implied by the immense development of eyes just referred to. Considering that out of the enormous number of young fish hatched with perfect eyes, not one in a hundred reaches maturity, what chance of surviving would there be for those with imperfect eyes? Inevitably they would be starved or be snapped up. Hence the chances that a matured or partially matured semi-blind fish, or rather two such, male and female, would be swept into a cave and left behind are extremely remote. Still more remote must the chances be in the case of crayfish. Sheltering themselves as these do under stones, in crevices, and in burrows which they make in the banks, and able quickly to anchor themselves to weeds or sticks by their claws, it seems scarcely supposable that any of them could be carried into a cave by a flood. What, then, is the probability that there will be two nearly blind ones, and that these will be thus carried? Then after this first extreme improbability, there comes a second, which we may, I think, rather call an impossibility. How would it be possible for creatures subject to so violent a change of habitat to survive? Surely death would quickly follow the subjection to such utterly unlike conditions and modes of life. The existence

of these blind cave-animals can be accounted for only by supposing that their remote ancestors began making excursions into the cave, and, finding it profitable, extended them, generation after generation, further in: undergoing the required adaptations little by little.

I turn now to Dr. Romanes. He says that I do not understand Weismann; and that the cause of degeneration to which he gives the name of "Panmixia" is not the continued selection of the smaller variations. Let us see what are Weismann's words.

"The complete disappearance of a rudimentary organ can only take place by the operation of natural selection; this principle will lead to its elimination, inasmuch as the disappearing structure takes the place and the nutriment of other useful and important organs" (Essays upon Heredity, p. 88).

"Those fluctuations on either side of the average which we call myopia and hypermetropia, occur in the same manner, and are due to the same causes, as those which operate in producing degeneration in the eyes of cave-dwelling animals" (Ib., p. 89).

Here, then, are two propositions: (1) "Fluctuations on either side of the average" "operate in producing degeneration in the eyes of cave-dwelling animals." (2) "A rudimentary organ" is removed "by the operation of natural selection." Why are "fluctuations on either side of the average" named, unless it is that natural selection takes advantage of them by preserving the smaller variations? If this is not meant the use of the expression is meaningless. Yet Dr. Romanes agrees with Weismann in regarding the "degenerated eye of the *Proteus* as a good example of the disappearance of a complex and useless structure by Panmixia."* So that Panmixia is clearly identified with the selection of the smaller variations; and for the reason that economy of nutrition is so achieved. Where, then, is the misunderstanding? That my interpretation is correct I have further reason for holding; namely, that it is the one given by Weismann's adherent, Prof. Lankester, in Nature, March 27, 1890 (pp. 487, 488). But while I can not admit my failure to understand Weismann, I confess that I do not understand Dr. Romanes. How, when natural selection, direct or reversed, is set aside, the mere cessation of selection should cause decrease of an organ *irrespective of the direct effects of disuse*, I am unable to see. Clearer conceptions of these matters would be reached if, instead of thinking in abstract terms, the physiological processes concerned were brought into the foreground. Beyond the production of changes in the sizes of parts by the selection of fortuitously arising variations, I can see but one other cause for the production of them—the

* Contemporary Review, April, 1893, p. 509.

competition among the parts for nutriment. This has the effect that active parts are well supplied and grow, while inactive parts are ill supplied and dwindle.* This competition is the cause of "economy of growth"; this is the cause of decrease from disuse; and this is the only conceivable cause of that decrease which Dr. Romanes contends follows the cessation of selection. The three things are aspects of the same thing. And now, before leaving this question, let me remark on the strange proposition which has to be defended by those who deny the dwindling of organs from disuse. Their proposition amounts to this:—that for a hundred generations an inactive organ may be partially denuded of blood all through life, and yet in the hundredth generation will be produced of just the same size as in the first!

There is one other passage in Dr. Romanes' criticism—that concerning the influence of a previous sire on progeny—which calls for comment. He sets down what he supposes Weismann will say in response to my argument. "First, he may question the fact." Well, after the additional evidence given above, I think he is not likely to do that; unless, indeed, it be that along with readiness to base conclusions on things "it is easy to imagine" there goes reluctance to accept testimony which it is difficult to doubt. Second, he is supposed to reply that "the germ-plasm of the first sire has in some way or another become partly commingled with that of the immature ova"; and Dr. Romanes goes on to describe how there may be millions of spermatozoa and "thousands of millions" of their contained "ids" around the ovaries, to which these secondary effects are due. But, on the one hand, he does not explain why in such case each subsequent ovum, as it becomes matured, is not fertilized by the sperm-cells present, or their contained germ-plasm, rendering all subsequent fecundations needless; and, on the other hand, he does not explain why, if this does not happen, the potency of this remaining germ-plasm is nevertheless such as to affect not only the next succeeding offspring, but all subsequent offspring. The irreconcilability of these two implications would, I think, sufficiently dispose of the supposition, even had we not daily multitudinous proofs that the surface of a mammalian ovarium is not a spermatheca. The third difficulty Dr. Romanes urges is the inconceivability of the process by which the germ-plasm of a preceding male parent affects the constitution of the female and her subsequent offspring. In response, I have to ask why he piles up a mountain of difficulties based on the assumption that Mr. Darwin's explanation of heredity by "Pangenesis" is the only available explana-

* See Social Organism in Westminster Review for January, 1860; also Principles of Sociology, § 247.

tion preceding that of Weismann? and why he presents these difficulties to me more especially, deliberately ignoring my own hypothesis of physiological units? It can not be that he is ignorant of this hypothesis, since the work in which it is variously set forth (Principles of Biology, §§ 66–97) is one with which he is well acquainted: witness his Scientific Evidences of Organic Evolution; and he has had recent reminders of it in Weismann's Germ-plasm, where it is repeatedly referred to. Why, then, does he assume that I abandon my own hypothesis and adopt that of Darwin, thereby entangling myself in difficulties which my own hypothesis avoids? If, as I have argued, the germ-plasm consists of substantially similar units (having only those minute differences expressive of individual and ancestral differences of structure), none of the complicated requirements which Dr. Romanes emphasizes exist, and the alleged inconceivability disappears.

Here I must end: not intending to say more, unless for some very urgent reason, and leaving others to carry on the discussion. I have, indeed, been led to suspend for a short time my proper work only by consciousness of the transcendent importance of the question at issue. As I have before contended, a right answer to the question whether acquired characters are or are not inherited, underlies right beliefs not only in Biology and Psychology, but also in Education, Ethics, and Politics.—*Contemporary Review.*

THE COLOR CHANGES OF FROGS.

By Prof. CLARENCE M. WEED.

ONE who, with observant eye, leisurely paddles among the water lilies of an inland lake must often notice how closely the colors of the various frogs resting upon or among the lily pads resemble their environment. In the open sunshine, where light green is the prevailing tint, the colors of the frogs closely approximate it, but in the dark and shady recesses of the forest-bordered banks the batrachians are dull, deep brown, with darker spots scattered over their bodies. These are the effects as seen from above. If one were to dive beneath the water and look upward, he would see in either case only the whitish undersides of their bodies and legs—if, indeed, these were visible against the general lightness of the upper world.

It is evident that this resemblance to environment might result in either of two ways: first, the light-colored frogs might seek the light surroundings and the dark ones the dark surroundings; or, second, the frogs, provided they had the power, might

change their color to agree with the environment. The latter method would, of course, from the frog's point of view, be decidedly the more desirable, saving him much exertion in seeking safe retreats; and recent researches have shown that this is in fact the method adopted.

The ability of the tree frogs, or "tree toads" (*Hylidæ*), to change their color has long been known, but precise studies of the color changes of the common ground frogs (*Ranidæ*) have only been made comparatively recently, and as yet the record is far from complete. A few years ago Dr. Fickert, of Tübingen, experimented with the color adaptability of the common European frog (*Rana temporaria*): "Three frogs approximately similar in color were placed in three glass vessels, of which the first stood on a black, the second on a green, and the third on a white surface, being surrounded up to a height of some five centimetres with the same color. After about an hour and a half the frog *a* on the black surface was the darkest, *b* on the white the lightest, while the frog *c* surrounded by green was intermediate in color between the two. Hereupon the frog *a* was transferred to the glass on the white, frog *b* into the one on the black surface. After three quarters of an hour they were again examined, and *a* was the lightest, *b* the darkest. Then *c* and *b* were interchanged, and in a quarter of an hour *c* was the darkest, while *b* was intermediate in color between *c* and *a*. When, finally, *b* and *a* were interchanged, a change of coloring appeared immediately; *b* became light again, and *a* took the intermediate tint between *b* and *c*." *

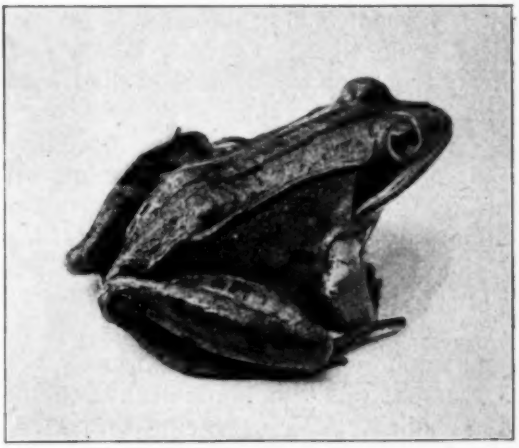


FIG. 1.—WOOD FROG. Adult.

A similar but less complete experiment with the same species of frog was made many years previously by Sir Joseph Lister, who found that "a frog caught in a recess in a black rock was itself almost black, but after it had been kept for about an hour on white flagstones in the sun was found to be dusky yellow, with dark spots here and there. It was then placed again in the hol-

* Eimer, Organic Evolution, Cunningham's translation, p. 148.

low of the rock, and in a quarter of an hour had resumed its former darkness." *

I have recently made a number of observations upon the commoner New England frogs which show that our species possess the power of color adaptation to a large extent. The prettiest of our frogs is the common wood frog (*Rana sylvatica*), a pale, reddish-brown species, nearly an inch and a half long when adult (Fig. 1), but very often found in the smaller immature condition (Fig. 2). It is most commonly seen on the carpets of pine needles in the woods, where its color is precisely like that of the bed of needles on which it lives. When found in fields and meadows away from the woods it is seldom reddish brown, being usually either light fawn color or dark brown.

A fine large wood frog was brought to my laboratory August 8th, and placed in a glass vivarium near a window. I began to study its color changes August 11th, at noon, adopting as a color standard the plates in Ridgway's admirable Nomenclature of Colors,† and the figures in parentheses hereafter refer to those plates. At the time mentioned the frog was light fawn color (III, 22) on the back. That night it escaped from the vivarium and wandered about the laboratory, being found the next day at 1 P. M. It was then much darker than before, the fawn color having changed to Van Dyke brown (III, 5), and the sides being dark clove brown (III, 2). Mr. Sylvatica was next placed in a dry glass jar, and put in a corner of the room with a white wall on two sides of it. Three days later (August 15th, 11 A. M.) it was an extremely light fawn color on the back (III, 22, but lighter), with the sides very light drab, approaching écru drab (III, 21).

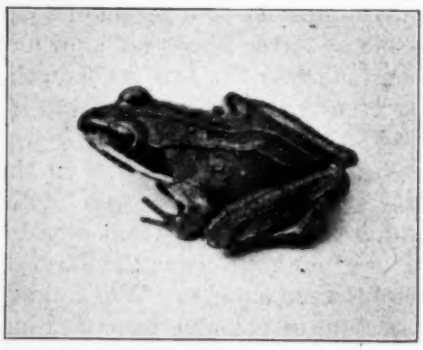


FIG. 2.—WOOD FROG. Immature.

A little water was next placed in the bottom of the jar, and it was put beside a blackboard, where it was left until August 23d. The frog was then cinnamon color (III, 20), with sides dark drab. I then placed it in an open window on a whitish bottom, and the next day it was light brown. At 2 P. M., August 24th, I put it on a jet-black shelf, with black surroundings. Forty-five minutes later it was very dark, nearly mummy brown (III, 10), but darker. At

* Poulton, Colors of Animals, p. 83.

† A Nomenclature of Colors for Naturalists, by Robert Ridgway, Boston, 1886.

3 P. M., while it was still so dark, I put it back in the window with white surroundings; at 3.05 it was considerably lighter brown, at 3.10 much lighter, and at 3.15 it had become cinnamon-colored —a very marked change thus occurring in fifteen minutes.

These experiments were repeated a number of times with several different individuals, and similar results were obtained.

The common green frog (*Rana clamata*) has the power of changing its color to a considerable extent. Specimens kept for some time amid light surroundings became of a very light green color—even lighter than apple green—while if placed amid a black environment they become very dark. The leopard frog, or spotted frog (*R. virescens*), is not able to change its appearance so completely, the permanent color markings preventing; but the green ground color varies somewhat. The few observations I have been able to make on the bullfrog (*R. catesbiana*) indicate that its ability in this direction is very similar to that of the green frog.

The power of color change is also present to a decided extent in our common toad (*Bufo lentiginosus*). A very large specimen of this species was found in wet grass June 1st, at 11 P. M. It was then of a light wax-yellow color. It was brought to the laboratory and put in a glass jar on a black shelf. Twenty-four hours later it was very much darker, being tawny olive brown. Three days later it had become still darker, being almost clove brown. A similar power has been observed in the European toad.

It is conceivable that these color changes might occur in either of two ways: First, by the direct action of the light reflected from the surroundings upon the pigment cells of the skins, and second, by an indirect action through the eye of the animal. The second method is the one involved. Experiments have shown that, when blinded, a frog does not change its color to agree with the environment. Mr. Poulton describes the process of change by saying that "certain kinds of light act as specific stimuli to the eye of the animal, and differing nervous impulses pass from this organ along the optic nerve to the brain. The brain being thus indirectly stimulated in a peculiar manner by various kinds of reflected light, originates different impulses, which pass from it along the nerves distributed to the skin, and cause varying states of concentration of the pigment in the cells. . . . The pigment cells in the skin are often of various colors, and are arranged in layers, so that very different effects may be produced by concentration in certain cells, leading to the appearance of those of another color, or to a combined effect due to the colors of two or more kinds of cells." *

* *Loc. cit.*, p. 85.

Probably the most important advantage derived by the frogs from their power of color change is that of concealment from birds and other enemies. Many of the larger waders devour these animals whenever opportunity offers, and a protective resemblance would help greatly in escaping detection. In the case of the wood frog, I suspect that the resemblance to the carpet of pine needles helps to preserve them from birds of other kinds—the hawks and owls. Last summer I placed a wood frog in a cage containing a red-tailed hawk (*Buteo borealis*), and it was immediately gobbled up by the bird.

It also seems likely that the resemblance to the environment may be of benefit to the species in enabling it more readily to obtain its insect food, but in the present state of our knowledge of the vision of insects one can not place very much stress upon this phase of the subject.

WHY A FILM OF OIL CAN CALM THE SEA.

By G. W. LITTLEHALES,
CHIEF OF DIVISION OF CHART CONSTRUCTION, UNITED STATES HYDROGRAPHIC OFFICE.

NEXT to the oil which is used in the beacons of the world to give light to save life, that which is most effective in forestalling the loss of life and the destruction of property is the quantity that is expended by mariners in forming a film around their vessels to subdue the violence of breaking waves. The extensive practice of using oil for this purpose is the outgrowth of an age of quick ocean passages which has impelled seamen to crowd on every foot of canvas and every pound of steam in the attempt to run through storm and calm alike. In any large seaport a visit to the docks where mariners tell the experiences of their voyages will afford evidence of the extent and efficacy of this practice; but, before proceeding to point out the principles involved, it will be of interest to give extracts from the log-books of a few vessels, to show the manner and effect of the use of oil. From the official notes of Captain Tregarthen, of the British steamship Marmanhense, the following extract has been made: "On March 3d, off Cape Hatteras, in a very strong northwest hurricane, finding the ship could make no headway, I hove to. The wind was blowing in hurricane force from the northwest, and the tremendous sea which was running broke on board and did great damage. The vessel was very unsteady, coming up and falling off several points, so that I could not steer her nor keep her head to the sea, although the engines were working well. I filled the water-closet bowls with oakum and poured fish oil over it, keeping men stationed by them to replenish the supply. I also filled a

small canvas bag with oakum, saturated with the same kind of oil, and towed it by a line from the weather bow of the vessel so that it would drift several fathoms to windward. The vessel now rode much more easily and could be kept head to sea. Moreover, no water came on board, and the sea was without breaking crests for thirty yards to windward of her. I feel no hesitancy in stating that, with the proper use of oil, I shall be perfectly willing to encounter the hardest gale that ever blew; and intend at the first opportunity, to stop the engines, place several oil bags to windward, and let the vessel drift as she will. I feel sure that the vessel will be safe under these conditions."

Captain Bower, while on a voyage from New York to the Mediterranean last December in the steamship Ponca, encountered a strong gale with very high seas. He says: "The vessel was deeply laden with grain and became unmanageable. We were running before the seas and shipping large quantities of water, until two small bags filled with colza oil were put over on each side of the bridge. This oil was found to be too light and of little use; but after olive oil was put in the bags no more water was shipped and the decks became almost as dry as in fine weather, although the gale continued for two days. The vessel was drawing twenty-six and a half feet of water, and, if we had not used oil, I do not think she could have withstood the storm."

Captain William Peake, master of the schooner J. F. Krantz, while making a passage from Port Spain, Trinidad, to Boston, met a terrific gale off Cape Hatteras and had the following experience: "The sails were blown away, men washed from the pumps, and boats and other things above the deck wrecked by the heavy seas. I was compelled to head southward and scud under bare poles. Then I thought of oil, and determined to see what effect it would have on the sea. Two wooden, ten-gallon kegs, containing boiled linseed oil, were lashed to the quarters of the vessel. The oil was allowed to ooze out through two small holes in the heads of the kegs. The effect was all that could be desired. After the oil had spread, no water came on board, the men returned to the pumps, the vessel was pumped out, and the decks were cleaned up. During the sixteen hours in which oil was used eight gallons were expended."

An examination of thousands of reports like the preceding ones demonstrates that a small quantity, say two quarts per hour, of the thick and heavy oils, especially those of animal and vegetable origin, when allowed to drop into the sea soon spreads over its surface, forming an oily layer within the area of which the waves, instead of breaking, become huge rollers upon which the vessels rise and fall without shocks and without shipping any water.

So much for the practical effects of oil on broken water. Now let us proceed to examine the reasons why so small a quantity of oil can produce these effects. In order to understand the methods for opposing the violence of waves, it is essential that the phenomena which constitute wave motion be understood. It can be said with some degree of confidence that there is no instance in Nature of a perfectly quiescent surface of water. Air and water are both mediums of extreme mobility, and the individual molecules of both, and of all other substances, are continually in a state of motion, with different velocities, in paths different in direction and length. There is thus a continual interlacing of particles. When air covers water, some of the particles of air, in their excursions, strike the surface of the water, producing unequal pressures upon it, and giving rise to ripples which the vision is not acute enough to detect. If the original surface of the water were perfectly smooth, and if all parts of it continued equally exposed to an equal wind, waves could not be produced. But with the minute corrugations which are always present upon the smoothest water it is to be observed that it does not occur that water is all equally exposed to equal winds. The pressure of moving air upon the crests and posterior portions of the minute corrugations is greater than that on the hollows and anterior portions. There is thus a tendency to heap up the water at the places of greatest pressure, which is augmented by the rotational or vortex motion produced by the viscosity of the air. These actions produce new forms and inequalities, which, exposed to the wind, generate new modifications of its force and give rise to further deviations from the primitive condition of the fluid. Imagine an isolated example in which the water has been suddenly heaped up by a gust of wind. The action of gravity causes the particles of water in the heap to push forward the particles immediately in front of them out of their former place to another place farther on, and they repose in their new place at rest as before the original heaping up. Thus in succession volume after volume continues to carry on a process of displacement which only ends with the exhaustion of the displacing force originally impressed and communicated from one to another successive mass of water. As the particles of water crowd upon one another in the act of going out of their old places into the new, the crowd forms a temporary heap visible on the surface of the water, and as each successive mass is displacing its successor there is always one such heap, and this heap travels apparently at that point where the process of displacement is going on; and although there may be only one crowd, yet it consists of always another and another set of migrating particles. This moving crowd constitutes a true wave. The velocity of the wave is the velocity with which the heap is seen to move. Its form is

the form of the heap. Its length is the distance from crest to crest, and its height is the distance from the crest to the surface of the water before the disturbance.

The motions of the individual particles of water are different from the motion of translation which the wave has. Consider a particle in a mass of water about to be traversed by a wave form. The action of gravity on the heap behind it tends to press it forward, where it is confronted by a solid wall of water. Under the action of these two opposite forces the particle is driven upward and forward until the particles which have displaced it have made room for themselves; then it sinks, and finally comes to rest a little in advance of the place from which it started. The motion of migration of each individual particle is thus in a closed orbit. The propagation of the wave is the advancement of a mere form. The actual translation of water in the propagation of unbroken waves is small. The motion of each particle takes place in a vertical plane parallel to the direction of propagation of the wave. The path of orbit described by each particle is approximately elliptic, and in water of nearly uniform depth the longer axis of the elliptic orbit is horizontal and the shorter vertical. When at the top of its path, the particle moves forward as regards the direction of propagation; when at the bottom, backward, as shown by the curved arrows in Fig. 1. The straight arrow denotes the direction of propagation.

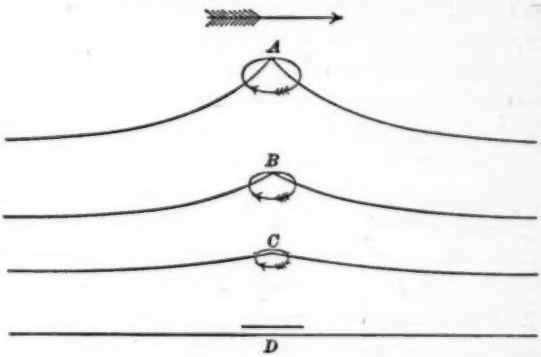


FIG. 1.

FIG. 2.

The particles at the surface describe the largest orbits. The extent of the motion horizontally and vertically diminishes with the depth below the surface. A particle in contact with the bottom of water of moderate depth moves backward and forward in a horizontal straight line, as at D. On the ocean, where the water is deep as compared with the length of a wave, the paths of the particles are nearly circular, and the motion is insensible at great depths.

When waves are first raised at sea their crests are smooth and rounded, as represented in Fig. 2. As the wind freshens the crests

rise higher and become more acuminate. Rankine has investigated the limiting forms which waves assume before breaking, and has concluded that in the steepest possible oscillatory waves of the irrotational kind, the crests become curved at the vertex in such a manner that a section of the crest by the plane of motion presents two branches of a curve which meet at an angle of ninety degrees.

After the prolonged action of the wind, when the crests of the waves rise to a considerable height and become sharper and sharper, the passage of the air over them with high velocity tends to impart its velocity to them. Owing to the inertia of the lower masses of water, the imparting of this velocity is resisted. The paths of the particles become distorted, as shown in Fig. 3, the front of each wave gradually becomes steeper than the back, and the crests seem to advance faster than the troughs, until at length the front of the wave curls over and breaks, as shown in Fig. 4.

FIG. 3.

Large sea-waves seem to be the result of a building-up process carried on by the joint action of large and small waves. If, for any cause, there be one wave larger than those surrounding it, its size will be continually increased at the expense of the smaller ones. For these smaller waves, in passing over the tops of the larger, offer increased obstruction to the wind and cause the formation of cusps when the waves coincide. The delicate equilibrium incident to a cusped form is easily destroyed by the action of the wind, and the crests of the waves break into fragments which go to increase the volume of large waves, leaving the small ones yet smaller. Therefore, whatever influence prevents the breaking of waves acts also as an agency to prevent their increase in size. No fact of observation and no method of sound reasoning has yet led to the conclusion that the spreading of oil on the surface of water agitated by waves can exercise any sensible effect in lessening the size or velocity of the waves themselves. It is in the breaking of the waves that the oil finds its field of action.

FIG. 4.

Having reviewed the structure of sea waves, the next step is to show why oil spreads over the surface of water. There is an attraction of one particle of water for another, and there is an attraction of one particle of oil for another, but there is a repulsion between a particle of water and a particle of oil. If we attempt to mix oil and water, the two liquids separate from each other of themselves, and in the act of separation sufficient force is brought into play to set in motion considerable masses of the fluids.

Imagine an individual particle of water within a mass of water.

The particles on every side of the individual particle attract it, and the attraction of opposite particles on every side tends to neutralize each other, so that the individual particle has almost perfect mobility. The surface particles, however, inasmuch as all the rest of the fluid is below them, are drawn inward toward the mass of the fluid, and a certain tension is produced. This tension is potential energy, and is inherent in the surface particles in virtue of their position. If we consider an oily film to be spread over the surface of a body of water, it will appear that the particles near the surfaces which separate the oil from the water and from the air must have greater energy than those in the interior of the film. The excess of energy due to this cause will be proportional to the area of the surface of separation. When this area is increased in any way, work must be done; and when it is allowed to contract, it does work upon other bodies. Hence it acts like a stretched sheet of India rubber, and exerts a tension of the same kind.

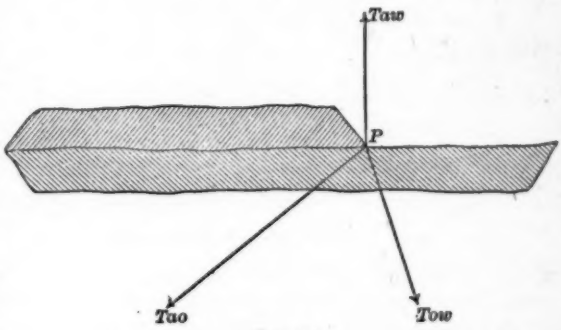


FIG. 5.

In the above figure, which represents an exaggerated picture of a layer of oil on the surface of a body of water, let *Taw* represent the superficial tension of the surface separating air from water; let *Tao* represent the superficial tension of the surface separating air from oil; let *Tow* represent the superficial tension of the surface separating oil from water; and let P be a point of the line forming the common intersection of the surfaces separating the air, oil, and water. For the equilibrium of these three media, the three tensions *Taw*, *Tao*, and *Tow* must be in equilibrium along the line of common intersection, and since these tensions have been measured and are known, the angles which their directions make with one another can be easily determined; for, by constructing a triangle, A B C, having sides proportional to these tensions, the exterior angles will be equal to the angles formed by the three surfaces of separation which meet in a line. But it is not always possible to construct a triangle with three given lines as its sides. If one of the lines is greater in length than the sum of the lengths of the other two, the triangle is impossible. For the same reason, if any one of the superficial

FIG. 6.

tensions is greater than the sum of the other two, the three fluids can not be in equilibrium in contact.

If, therefore, the tension of the surface separating air from water is greater than the sum of the tensions of the surfaces separating air from oil and oil from water, then a drop of oil can not be in equilibrium on the surface of water. The edge of the drop where the air meets the oil and the water becomes thinner and thinner, till it covers a vast expanse of water.

M. Quinke has determined the superficial tensions of different liquids in contact with one another and with air, and the following is an extract from his table of results. The tension is measured in grammes per linear centimetre at twenty degrees centigrade:

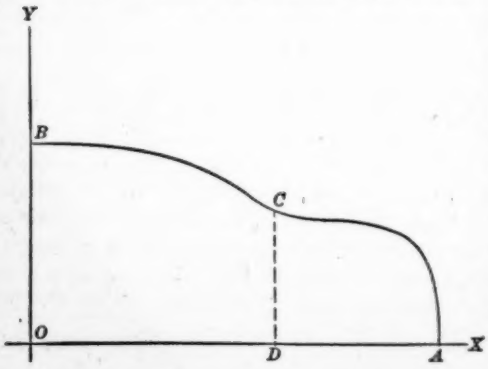
Liquid.	Specific gravity.	Tension of surface separating liquid from air.	Tension of surface separating liquid from water.
Water	1·0000	·08235	·00000
Olive oil	0·9136	·03760	·02096

Although olive oil is here taken as the representative of oils, it is not considered so well adapted for use at sea as some of the others. Whale oil has given the best results, but its surface tensions do not seem to have been determined. It may be presumed that they do not differ greatly from the values given for olive oil.

An inspection of the above table will show that the tension of the surface separating air from water is greater than the sum of the tensions of the surfaces separating air from oil and oil from water, which explains why a film of oil will spread over the surface of a body of water.

Through the operation of surface tensions much of the force which breakers have is lost. Let us imagine a "break" to occur after the surface of the water is covered by the oily film.* For

* Above it has been assumed that the *superficial tension per unit of length* has the same numerical value as the *superficial energy per unit of area*, which can be proved as follows:



Let the equation to the curve B C A be $y = f(x)$. Take any ordinate, as C D, whose length is y, and let the whole tension exerted across the line be represented by ϕ, then the superficial tension is measured by the tension across a unit length of y, or, since ϕ is the tension across the whole ordinate y, if T, which is constant, is the superficial tension per unit of length, $\phi = Ty = T \cdot f(x)$. Suppose that the variable ordinate y is originally in contact with the axis O B, and that the surface included

every square centimetre of film torn asunder there will be destroyed ·05856 centigrammetre of potential energy, being the sum of ·03760 and ·02096, the potential or surface energies, in centigrammetres per square centimetre, of the surfaces separating air from oil and oil from water; and there will be generated for every square centimetre of free surface of water formed, ·08235 centigrammetre of potential energy. The mere fact of breaking the film of oil causes an expenditure of energy, because it lays bare a surface having a tension greater than the sum of the tensions of the surfaces separating air from oil and oil from water. But there is a further loss of energy in these circumstances. Suppose after a "break" has occurred, a layer of water glides over a layer of oil. The superficial energy in the surface separating the oil from the air, amounting to ·03760 centigrammetres per square centimetre, is replaced by ·10331 centigrammetre per square centimetre, being the sum of ·08235 and ·02096, the superficial energies per square centimetre of the surfaces separating air from water and water from oil respectively. Therefore, when water breaks over an oily film, there is required for the formation of each square centimetre of a layer of water on the oily film, ·10331 minus ·03760, or ·06571 centigrammetre of work.

The film of oil also acts as a shield to prevent the derangement of the wave mechanism and to prevent the growth of waves and the formation of sharp crests. It has been pointed out that, when waves are propagated across any body of liquid, the individual particles of the liquid, having their centrifugal and centripetal forces in equilibrium, describe closed orbits. At the highest points of these orbits, or in the crests of the waves, the particles are moving in the direction of propagation of the waves.

When the wind is blowing over the waves with a velocity greater than the velocity of propagation, and in the same direction with it, the moving air tends to impart to the particles of water a velocity additional to the normal velocity of revolution in their orbits, causing the distortion of the orbits and the disintegration of the crests of the waves. The force which the moving air exerts to draw the water along with it is due to the viscosity of air.

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between the curve and the two axes is produced by drawing the ordinate y away from the axis O B toward the right by the action of the force ϕ. If we consider O B and D C, which is equal to y, to be two rods wet with oil and placed between the curve and the axis of X, and then drawn asunder, the oily film B C A D O will be formed. Let E represent the superficial energy per unit of area. Then the work done in forming the film will be $= Eff(x)\,dx$. But if ϕ is the variable force required to draw the ordinate y from the axis O B, the same work may be written $= f\phi\,dx$. Therefore, work $= f\phi\,dx = Eff(x)\,dx$ (1). Substituting the value $\phi = Tf(x)$ in (1), we have $Tff(x)\,dx = Eff(x)\,dx$, or T = E, or that the numerical value of the superficial tension per unit of length is equal to the superficial energy per unit of area.

When wind blows over water, all the air does not pass over the surface of the water. On account of the high degree of adhesion between air and water, a thin stratum of air remains in contact with the water, and it is the action of the internal friction or viscosity of air tending to draw this stratum along which causes the tractive effect of wind on water.

When a film of oil is spread over the surface, this tractive force is not brought to bear on the surface of the water as long as the film remains unbroken, but acts upon the surface of the film, whose particles, being entirely separate from the particles of water, do not share their motion. The surface of the water is thus shielded from the action of the wind in the same manner as if a skin of India rubber were spread over it, and the only action of the wind in such a case is to move the film over the surface of the water.

It is calculated that a wind moving at the rate of twenty-five miles per hour or one hundred and twelve centimetres per second, relatively to the surface of the water, exercises a tractive effect of about two thousandths of a gramme upon each square centimetre of surface; and, when we consider that this force is brought to bear upon a system of particles moving in their orbits, in the direction in which the wind blows, with a speed of about eighty centimetres per second, it will be apparent that the interposition of a film of oil between the air and water must have a powerful effect in preventing breaking crests.

Observation has shown that, in the generation of oscillatory waves, ripples or capillary waves are first formed, and that it is to the union of conterminal ripples and to their more abundant formation with the increased force of the wind that the growth of waves is due. The existence of a certain definite tension, equal to ·08235 gramme per lineal centimetre, at the common surface of air and water has been pointed out. The water surface under this tension is in perfect equilibrium.

When wind blows over the surface of a body of water, the tangential force which the air, in virtue of its viscosity, exerts on the surface of the water, is of different degrees of intensity at different places, owing to the minute corrugations which are always present on the surface of a body of water, and to the eddying motion of the air. At the places where the tangential force is greatest, the surface film of water is drawn along and the portions of the surface immediately in front of them, destroying their surface tension or energy of position, and, by laying bare new surface in places from which they are moved, generating a like amount of surface tension. Through this action heaps or ripples are formed, and surface tension is being constantly generated and destroyed. The formation of ripples takes place on waves already in exist-

ence in the same manner as upon a surface of water originally at rest, and by continually uniting with the larger waves they impart those dangerous qualities to the wave which result from high and acuminate crests.

When a film of oil is spread over the surface of the water, this heaping-up action, which in the case of the water film results in the formation of ripples, can not take place. In the figure, let A represent the crest of a wave covered by the film of oil B C, and let P be a point of greatest action of the tangential force of the wind, which is supposed to move in the direction of the arrow. The tendency of this action is to drive the film into a heap immediately in front of P. By this action a greater tension is generated in the film at *b* and a lesser tension at *a*. The greater tension at *b* tends to draw the portion at *b'* ahead, and the lesser tension at *a* allows the tension at *a'* to draw the portion at *a* ahead; so that, instead of a tendency toward heaping up, there is a tendency to move the entire surface film along at a uniform rate. The formation of ripples is therefore stopped, and the growth of waves and the formation of breaking crests, as far as they result from this cause, are prevented.

FIG. 7.

HOW PLANTS AND ANIMALS GROW.

BY DR. MANLY MILES.

TOO little is known in regard to the chemistry of foods, or the specific use made of their proximate constituents in the processes of nutrition, to serve as a rational guide in formulating diets, or estimating the relative nutritive value of different articles of food. Our methods of chemical investigation are not as yet sufficiently delicate and refined to enable us to trace the unobtrusive transformations of matter and energy involved in the nutrition of living beings.

Liebig's chemical theories of nutrition are now discarded by physiologists as fallacious and misleading, but they are, nevertheless, confidently adopted by popular writers on the economy of foods and diets, who are not aware of the progress made in a more consistent knowledge of physiological processes. The history of biological science furnishes numerous instances of error arising from the undue prominence given to non-essential details which are readily observed, while the dominant factors in the phenomena under investigation, which are not so obvious, are overlooked or assigned a subordinate position.

The progressive development of the cell theory of organic structure, and the several steps which have led to a recognition of protoplasm as a factor in evolution and in the processes of vegetable and animal nutrition, may be profitably reviewed to illustrate the erroneous inferences made from superficial and defective observation. In 1755 Rosenhoff described the *Proteus* animalcule, now familiarly known as the *Amœba*, without being aware of the importance of the discovery in furnishing a type of the form or conditions of matter required for the manifestations of life.

Bichat laid the foundation for the study of the minute structure of animals in his work on anatomy, published in 1801, in which the different organs of the body were described as made up of tissues, to each of which was assigned a special function, and the attention of anatomists was then given to the distribution and arrangement of these structural elements, while their intimate relations, arising from a common origin, were not detected.

The next step of real progress was made in 1838 by Schleiden, who traced all vegetable tissues to the common form of nucleated cells from which they had their origin, and in 1839 Schwann perfected the cell theory of organization by extending the same conception to animal tissues. Cells were then recognized as the ultimate units of organic structure, which were variously modified to adapt them to diverse special purposes. This cell theory of organized structure was generally adopted, and cells were defined as closed membranes or sacs, containing a more or less fluid substance which served to nourish them. The cells were looked upon as independent units, which multiplied by a process of budding or by self-division, and a new factor was introduced in the discussion of the mooted question as to what constitutes the individual in plants. Schwann "regarded the plant as a cell community in which the separate elements were like the bees in a swarm," and this appeared to be a logical inference from the accepted cell theory of organization.

This view was, however, based on an erroneous assumption as to the essential constituents of the cell, and the progress of discovery gradually led to the demonstration of a material and physiological bond of union in the various tissues of plants. In 1835 Dujardin made the discovery that the bodies of *Foraminifera*, a group of animals of simple organization, including the *Amœba*, were composed of a glairy contractile substance, which he called *sarcode* (rudimentary flesh), and in 1846 Von Mohl called attention to the importance of the inner lining of the cell wall of plants, which he designated the *primordial utricle*, with its inclosed contents, to which he gave the name of *protoplasm* (primitive plastic or organizable matter), and these, he claimed, repre-

sented the essential constituents of the cell and active elements in plant nutrition.

The identity in essential features of Dujardin's sarcode and Von Mohl's protoplasm was pointed out by Cohn in 1850, and fully demonstrated by Max Schultze in 1858, who, adopting the term *protoplasm*, defined the cell as "a unit-mass of nucleated protoplasm, with or without a cell wall," and vegetable and animal physiology were thus placed on a common correlated basis. The original cell theory was materially modified and, in fact, superseded by the conception that the units of organized structure are masses of protoplasm, more or less intimately related, from and by which organic matters, including the cells and various tissues, were formed.

In 1868 Prof. Huxley translated protoplasm into the significant phrase, "the physical basis of life," and all vital activities were assumed to be the result of its inherent properties. While admitting the general pertinence of this assumption, we should not fail to notice that many of the inferences from the facts then known have not been verified in the progress of knowledge, and recent investigations have materially modified our views as to the real composition and constitution of protoplasm.

From what was known in regard to protoplasm twenty years ago, it appeared to be reasonable to assume with Huxley that there is "one kind of matter which is common to all living beings, and that their endless diversities are bound together by a physical as well as an ideal unity"; that vegetable and animal protoplasm are strictly identical; that "an animal can not make protoplasm, but must take it ready made from some other animal or some plant"; or, in other words, that the protoplasm made by plants from mineral matters is, in fact, the physical basis of animal life.

At the present time we may look upon protoplasm as the physical basis of life in the sense that some form of it is the essential and active constituent of every living cell or tissue, whether vegetable or animal, and that it is only formed through the physiological activities of living organisms. In the absence of life, protoplasm can not be formed, and, so far as we can perceive, there are no manifestations of life without it; but we can no longer assume that it is a substance of the same chemical composition and constitution in all the varied conditions under which it appears in the different groups of plants and animals, or even in the different organs of the same individual. Protoplasm is a convenient name for living substance, but we must bear in mind that it is the most complex and unstable of organic substances, and varies widely in structure, specific properties, and probably in chemical composition.

The general properties of protoplasm may be readily observed in the simplest organic forms, like the *Amœba*, that are usually described as simple masses of protoplasm without structure or any distinction of parts. It should be remarked, however, that numerous species of *Amœba* have been described, differing in form and to some extent in habits, and there may also be differences in their protoplasm which we are unable to detect with our present means of investigation.

Under the low powers of the microscope an *Amœba* appears as a semi-transparent, jelly-like mass, which glides along with a flowing movement of its apparently homogeneous substance, sending out armlike projections from any part of its body to close around substances which it can feed upon, and rejecting other materials unsuitable for its nutrition. The processes of prehension, digestion, assimilation, respiration, excretion, and reproduction are carried on by the entire body, or by any part of it indifferently. The body of an *Amœba*, as we observe it, is not, however, a simple mass of protoplasm, as it evidently contains particles of undigested food, with particles representing the various stages the elements of the food pass through in being built up into protoplasm, together with the various waste products on the way to be excreted, so that what we call protoplasm, as represented in an *Amœba*, contains many extraneous substances; and substantially the same statement may also be made in regard to the differentiated protoplasm of the higher plants and animals.

From this it must be seen that it is practically impossible to obtain samples of pure protoplasm for analysis, and, even if this could be done, a chemical analysis of living protoplasm can not be made; but there is, however, evidence to show that there must be a wide difference in the chemical properties of living and of dead protoplasm. Carmine and other coloring matters, for example, do not color living protoplasm, but give a brilliant stain to dead protoplasm; and other observations show that living substance has properties that interfere with or limit the ordinary chemical and physical reactions of dead matter.

There are other considerations in regard to the composition of protoplasm which require a reference to the food of the higher animals, which is usually said to consist of the so-called proteids, fats, and carbohydrates, to which should be added certain mineral constituents or salts, with oxygen introduced by the lungs. These groups of food-stuffs have not the physiological significance that was formerly attached to them, and they do not represent definite chemical compounds which have a specific *rôle* in the processes of nutrition, as each group includes a great variety of complex compounds. The proteids or albuminoids, as they are sometimes called, are a group of organic substances containing carbon, hy-

drogen, and oxygen, with from fifteen to eighteen per cent of nitrogen and a variable quantity of ash constituents, and they present marked differences in their general appearance and properties. The white of an egg, the casein of cheese, the glutin of wheat, and the legumin of peas and beans are often referred to as typical proteids, but they in fact represent several kinds of proteids which differ in many properties, and can not be assumed to have precisely the same physiological significance and value as nutrients.

The group of fats includes a great variety of compounds composed of carbon, hydrogen, and oxygen, without nitrogen, and their properties are various. The carbohydrates are likewise composed of carbon, hydrogen, and oxygen, without nitrogen, and they include starch, sugar, cellulose, woody fiber, and allied substances, differing in form and various properties, so that their physiological value can not be the same. Oxygen is the most abundant element of the animal body as a whole, and it stands next to carbon in the percentage composition of the proximate constituents of the tissues. Its significance as a food element is too often overlooked, but it is undoubtedly as important a factor in tissue-building as any other food constituent.

Protoplasm was formerly looked upon as a proteid, but it is now generally admitted that its composition and structure are very much more complex than any form of proteid. The chemical composition of living protoplasm, as already pointed out, can not be determined, but there is evidence that proteids, fats, and carbohydrates enter into the composition of its complex molecules, and it gives rise to all three of these groups of nutrients in the processes of destructive metabolism, and it should also be noted that several varieties of proteid matter have been detected in dead protoplasm.

Energy has been defined as the power of doing work, and it is expended in the work involved in building protoplasm out of the simpler proteids, fats, and carbohydrates from which it is formed. An essential constituent of the complex molecules of protoplasm which is neglected in chemical analysis is the potential energy stored up as a result of the constructive process, which is liberated in the form of heat in destructive metabolism. The properties of living protoplasm, and its *rôle* in the vital activities of plants and animals, have been more definitely determined than its chemical constitution, and although it is generally admitted to be the dominant factor in nutrition, there is yet much to learn in regard to its properties and specific action in its diverse forms.

Living protoplasm, or, in other words, living substance, must be looked upon as constantly undergoing changes that vary with the function required of it. These changes, without attempting

to distinguish between them as chemical, physical, or more strictly biological, are conveniently expressed by the general term *metabolism.*

Dr. M. Foster says: "We may picture to ourselves this total change which we denote by the term 'metabolism' as consisting, on the one hand, of a downward series of changes (katabolic changes), a stair of many steps, in which more complex bodies are broken down into simpler and simpler waste bodies, and, on the other hand, of an upward series of changes (anabolic changes), also a stair of many steps, by which the dead food, of varying simplicity or complexity, is, with the further assumption of energy, built up into more and more complex bodies. The summit of this double stair we call 'protoplasm.' Whether we have the right to speak of it as a single body in the chemical sense of that word, or as a mixture in some way of several bodies; whether we should regard it as the very summit of the double stair, or as embracing as well the topmost steps on either side, we can not at present tell. Even if there be a single substance forming the summit, its existence is absolutely temporary: at one instant it is made, at the next it is unmade. Matter which is passing through the phase of life rolls up the ascending steps to the top, and forthwith rolls down on the other side."

The greater activity of the nutritive processes in young and growing animals, with a gradual decline to maturity and old age, are matters of common observation. Dr. Minot has, however, shown that "with the increasing development of the organism and its advance in age we find an increase in the amount of protoplasm.* This seems to indicate that katabolism is relatively more active in young organisms, and that they use protoplasm in tissue-building as fast as it is formed. In old age, on the other hand, the anabolic processes resulting in the formation of protoplasm are not diminished as rapidly as the katabolic transformations of protoplasm into new tissues, to replace the waste arising from the wear and tear of the system, and a general decline of the bodily powers follows.

As we pass from the simpler to the higher forms of life we find a gradual transition from the comparatively homogeneous protoplasm of the lowest, to the highly differentiated protoplasm of the highest forms which provide for a division of labor in the physiological activities of the different organs. In the highest organisms the functions of prehension, digestion, assimilation, respiration, etc., as in the *Amœba,* are still carried on through the agency of protoplasm, but it is distributed to various organs, each of which has a special function.

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* Trans. A. A. A. S., 1890, p. 283.

Plant cells are not independent units as assumed in the cell theory of organic structure, as recent investigations, with improved microscopes and more exact methods of research, have shown that the protoplasm of adjacent cells is connected by slender threads which pass through minute openings in the cell walls, and this has been observed in so many cases that the continuity of their protoplasm is believed to be the rule in the structure of plants. The various tissues and cells of the higher plants have, therefore, a common bond of union in the connecting threads of protoplasm which determine their harmonious action.

The higher powers of the microscope likewise show that the protoplasm of plants is not homogeneous, but contains numerous granules which repeat themselves indefinitely by a process of self-division, each granule having a genetic relation to pre-existing granules of the same kind. Besides the granules, each protoplasmic cell has a nucleus which in the same manner is formed by the self-division of a pre-existing nucleus. The granules, and especially the nucleus, may prove to be important factors in the perpetuation of ancestral characters, and consequently more intimately involved than other elements in the grand mystery of life.

The chlorophyll granules which constitute the green coloring matter of plants were supposed to be formed from the protoplasm in which they appear; but they are now known to arise from the pre-existing self-propagating granules of protoplasm.

The conception of ascending steps of constructive metabolism resulting in the formation of protoplasm and the storing of energy, with correlated descending steps, by which protoplasm is transformed into less complex compounds (destructive metabolism), with a liberation of energy, serves as a key to the complex processes of nutrition which enables us to trace their conformity to general laws that are readily recognized, and clears up the obscurity arising from the multiplicity of details which from other points of view could not be brought into consistent relations.

In the light of these principles the relations of protoplasm to the leading features of vegetable nutrition may be traced in brief outlines, as a prelude to the more highly differentiated processes of animal nutrition. The latest discoveries in physiology all tend to verify the conclusion that the simple chemical elements and binary compounds, which constitute the food of plants, are built up by successive steps of gradually increasing complexity into protoplasm, or living substance, the ultimate product of constructive metabolism, and that the energy expended in the work performed is stored in the form of potential energy as an essential element or condition of its constitution. From the instability of the exceedingly complex molecules of protoplasm, destructive metabolism immediately follows, and the proximate constituents

of plants known as proteids, starch, cellulose, etc., are formed in the downward steps of its progress with a liberation of a portion of the stored energy in the form of heat. The heat liberated in these first steps of destructive metabolism is not, however, sufficient to maintain an independent temperature in plants, as it is used in vaporizing the water exhaled in the processes of growth, or lost by radiation from the extended surface of foliage. The energy expended in vaporizing water must be considerable, as experiments show that for each pound of dry organic substance formed by the plant about three hundred pounds of water are exhaled in the form of vapor.*

The products of the downward steps of metabolism are numerous, some of which, as waste matters, are either excreted, as in the case of carbonic acid and water, or deposited in the more stable tissues; while others called plastic products, including proteids, starch, fats, etc., are stored as reserve materials to be used in constructive metabolism when needed by the plant. These reserve materials are not as a general rule stored in the place where they are formed, and they can only be transported when changed to a soluble form, which is brought about by certain "soluble ferments," which are also products of the destructive metabolism of protoplasm. Starch formed in the leaves is changed to glucose and transported to other parts of the plants where it is reconverted into starch and stored for use, sooner or later, in constructive metabolism. Some of these reserve materials are apparently built up again into protoplasm before they are resolved into their ultimate products. This is seen in the starch deposited in oily seeds which is used in forming protoplasm, and the oil is then formed as a product of its metabolism.

The many forms of organic acids—as the malic, tartaric, oxalic, citric, etc.—and a variety of alkaloids and other bodies are also products of destructive metabolism, which may be deposited in the various tissues as waste materials, or some of them may be changed by soluble ferments into forms which may be again utilized in the economy of the plant. The organic acids and tannin of green fruits, for example, are converted into sugar in the process of ripening by ferments formed from the protoplasm of the fruit cells.

In general terms the processes of nutrition in plants may, then, be said to consist in the construction of protoplasm from the elements of their food, with a storing of energy, and the conversion of this protoplasm into the various organic substances entering into the composition of their tissues (starch, cellulose, etc.), with a liberation of energy, and all vital activities are included in

* Popular Science Monthly, May, 1892, p. 92.

these upward and downward transformations of matter and energy.

In the higher animals the various functions are more highly specialized, but we still find that protoplasm is the essential living substance of every tissue and the dominant factor in nutrition. It differs, however, from vegetable protoplasm in many of its properties, and it can not, as formerly assumed, be formed by plants, or built up from the simpler elements that plants feed on, and from which they construct vegetable protoplasm.

The proteids, fats, and carbohydrates which constitute the food of animals are, as we have seen, products of the destructive metabolism of the protoplasm of plants, and it was formerly supposed that they are transformed into animal proteids and fats, without any marked change in their chemical constitution. This assumption is, in fact, the basis of the fallacious theory of nutritive ratios, but it can not be reconciled with the known facts of animal nutrition. There appears to be conclusive evidence that the proteids, fats, and carbohydrates of the food can not be converted into the proteids and fats of the animal body without undergoing profound disruption and reconstruction through the agency of animal protoplasm; or, in other words, the products of vegetable protoplasm can not be made available in the construction of animal tissues without being resolved into simpler compounds and formed anew in the laboratory of animal life.

Without noticing the many details that would only tend to divert the attention of the general reader from the significance of the results produced, the essential or fundamental processes in the nutrition of the higher animals may be broadly stated as follows: In the first place, the proteids, fats, and carbohydrates of their food undergo a series of changes in the processes of digestion (using this word in its widest sense) that reduces them to simpler compounds and, in fact, almost to their elements, with a liberation of energy which is made available in the reconstruction of the disintegrated food constituents.

The activities of the various organs of nutrition are primarily directed to the elaboration of a nutritive fluid, the blood, which is distributed to all of the tissues through the circulatory apparatus provided for that purpose, funishing them the pabulum for their nutrition, and receiving the excretory and other products arising from their metabolism. "An average uniform composition of the blood" is maintained through the action of numerous glandular organs, and the drafts made upon it in the constant repair of the different tissues. The various ferments required in the disintegration or digestion of the food elements that are being transformed into blood are products of the destructive metabo-

lism of the protoplasm of the special secreting organs and of the general tissues.

From the common nutritive fluid, the blood, protoplasm is formed in all the tissues of the body, and we must look upon the characteristic elements and products of these tissues as the result of its destructive metabolism. In each organ of the body the protoplasm appears to have special endowments adapted to their specific functions, but these diverse activities are correlated to serve a common purpose in the life of the individual. The contraction of muscles, the specific secretions of the glandular organs, including the salivary glands, the liver, the pancreas, the mammary glands, etc., and, in fact, the products of all the metabolic tissues, as well as their characteristic structural elements, must be considered as the resulting products of the downward steps of the metabolism of protoplasm.

As in plants the food elements are built up into protoplasm before they are converted into the proximate constituents of plant tissues (proteids, fats, starch, etc.), so in animal nutrition it appears that the proteids, fats, and carbohydrates, together with oxygen introduced by the lungs, which constitute their food, must pass through the intermediate phases of blood and protoplasm before they appear as animal proteids and fats, or enter into the composition of the different tissues of the animal body, so that a genetic or specific relation of particular tissues to special food constituents can not be traced.

For example, the muscles, from their comparative bulk, contain a large proportion of the nitrogen of the body, and they are spoken of as nitrogenous tissues, but they are not formed directly from the proteid or nitrogenous constituents of the food. Like all other tissues, they have their origin in protoplasm that is built up from the common nutritive fluid, the blood, which is elaborated, as we have seen, from the disintegrated elements of fats and carbohydrates as well as proteids. Moreover, nitrogen is no more essential to the formation of muscle than carbon or oxygen, or even water, which are more abundant constituents of all living tissues.

It must then be evident that we can not formulate the proportions of the proximate principles of foods that will serve the best purpose in animal nutrition. The extended and profound series of changes that intervene between the food constituents on the one hand and the resulting animal tissues on the other are too complex to enable us to trace any direct chemical relations between the initial elements and their final products. Aside from these physiological considerations there are insuperable obstacles in the way of prescribing diets that are even approximately suited to the requirements of any particular individual, or group of

animals, arising from individual peculiarities and inherited ancestral habits. Experiments have not as yet been made with a sufficient number of individuals or with a sufficient variety of foods to warrant any generalizations as to what constitutes a normal diet for either man or beast under even average conditions.

The recent recognition of energy as one of the most important factors in physiology has led to the rejection of the purely chemical theories that were formerly quite generally accepted in regard to the *rôle* of particular food constituents in the processes of nutrition. An assumed combustion of food constituents is no longer required to explain the phenomena of animal heat, which is now known to be but a phase in the transformations of energy in the processes of nutrition.

Energy is expended in building organic substance, or, in other words, in converting food-stuffs of any kind into protoplasm, the summit of the double stair of life, and its potential energy is the transformed or stored energy of the constructive process. This combined energy, in accordance with the law of conservation, may be liberated in the form of heat to a greater or less extent in various ways by the more or less complete disintegration of the organic substance in which it is stored. If the process of disintegration is carried on until the organic substance is resolved into its original elements, the heat liberated is the exact equivalent of the energy expended in its construction.

In living organisms the descending steps of metabolism are but successive phases of normal vital activities, resulting in the formation of a definite series of organic substances which contain less potential energy than the protoplasm from which they are formed, and heat must therefore be liberated as they are elaborated. Dead organic matters may be torn apart by microbes and resolved by a widely different series of descending steps into their original elements, as in the processes of fermentation and putrefaction, with a complete transformation of their potential energy into heat. The same ultimate result may likewise be obtained by burning organic substances, but the intervening steps and products of the destructive process are less numerous and of a different character than those produced by vital activities, while the heat liberated is still the transformed energy of the constructive process.

Plants derive the energy required to convert simple chemical elements into the complex molecules of protoplasm from the heat and light of the sun, while on the other hand the energy expended in the constructive processes of animals is exclusively derived from the potential energy of their food (stored energy of plants), and a disintegration and apparent waste of the material, or chem-

ical constituents of foods, become necessary to liberate their needed supplies of energy.

As all the food constituents contribute to the blood-making processes, they all in like manner through digestive disintegration contribute to the supplies of energy required in the animal economy. The energy provided in foods in the potential form is quite as important in building animal tissues as the chemical elements entering into their composition, as when liberated in the form of heat it is utilized in constructive metabolism and stored again as potential energy in the animal tissues formed. The destructive metabolism taking place in these tissues, as an essential concomitant of their vital activities, again liberates energy in the form of heat, which, with that derived from the digestion of foods, is used, so far as needed, in the reconstructive process, and the balance appears as animal heat.

We have noticed the recently discovered continuity of the protoplasm of plants, but we can not fairly infer that there is a similar continuity of the protoplasm of the higher animals that have a highly specialized nervous system which brings the different organs and functions into harmonious action more completely and efficiently than they could be by simple threads of protoplasm like those which unite the cells of plants. The widely different products of destructive metabolism in the various tissues of plants and animals, aside from other considerations, furnish conclusive evidence that while the general *rôle* of protoplasm is everywhere the same, it must differ materially in composition and constitution in the different conditions in which it is found. As stated by Dr. Foster, "It is obvious that the varieties of protoplasm are numerous, indeed almost innumerable. The muscular protoplasm which brings forth a contractile katastate must differ in nature, in composition—that is, in construction—from glandular protoplasm whose katastate is a mother of ferment. Further, the protoplasm of the swiftly contracting striped muscular fiber must differ from that of the torpid, smooth, unstriated fiber; the protoplasm of human muscle must differ from that of a sheep or frog; the protoplasm of one muscle must differ from that of another muscle in the same kind of animal, and the protoplasm of Smith's biceps must differ from that of Jones's."

What determines these differences and gives direction to such diverse metabolic activities? Chemical and physical considerations fail to clear up the mystery of life and its varied manifestations. We may look upon protoplasm as the physical basis of life, and consider vital activities as resulting from its inherent properties; but this does not aid us in gaining a better knowledge of the mysterious endowments of living matter. What gives rise to these diverse properties in different species and in different

organs of the same individual? We can not attribute them to organization or structure, as so far as we know these are the result of vital activities, and can not, therefore, be the cause. As forcibly stated by Prof. Huxley in his paper on the cell theory (1852), cells "are no more the producers of the vital phenomena than the shells scattered in orderly lines along the sea-beach are the instruments by which the gravitative force of the moon acts upon the ocean. Like these, the cells mark only where the vital tides have been and how they have acted."

It has been suggested that the various factors in nutrition, including even "structure" and "composition," must be looked upon as modes of motion in accordance with the concepts of modern physics, and from this point of view the body of a man has been compared to a fountain. "As the figure of the fountain remains the same, though fresh water is continuously rising and falling, so the body seems the same, though fresh food is always replacing the old man, which in turn is always falling back to dust. And the conception which we are urging now is one which carries an analogous idea into the study of all molecular phenomena of the body."

The pertinence and significance of these physical considerations should not, however, lead us to assume that life is but a form of energy. We can not doubt that energy is the motive power in living beings, and that its transformations and activities which are evident in all organic processes are properly considered as modes of motion, but we must discriminate between the motive power that does the work and the directing force which guides it in the lines along which it acts and determines the results produced. We are unable to detect any difference in the potential energy of living and of dead protoplasm, but we recognize an immense difference in their significant properties—a difference so wide that life can not be defined as a form of energy.

The manifestations of energy in organic processes are readily perceived, and there are definite standards with which to measure them, but our most delicate means of research throw no light on the purely vital endowments of protoplasm, which not only direct and control its activities, but are transmitted in well-defined characters from parent to offspring. There is no life without preexisting life from which it is derived, and the physical basis through which it acts, or is made manifest, furnishes no satisfactory explanation as to its real essence and constitution.

In discussing the economies of foods and diets, if we keep in mind the significant facts that vital activities direct and determine the transformations of energy and the collocations of matter in plants and animals, in accordance with the nutritive requirements of every organ and tissue, and that in the higher animals

the food supplies of the various tissues that differ so widely in composition and function are derived from the same common pabulum, the blood, which under the varying conditions of supply and demand maintains a comparatively uniform composition—the futility of assigning to each or any element of the food a specific *rôle* in the processes of nutrition must be obvious.

THE REVIVAL OF WITCHCRAFT.

By ERNEST HART.

II.

FINALLY, I must refer to another set of experiments which Dr. Luys conducted before us at La Charité on two of the patients there (on whom I subsequently performed counter-experiments). Having thrown these patients into the state of artificial sleep, he took from his pocket some sealed glass tubes. "This tube," he said, "contains alcohol." He placed the tube in contact with the skin of the patient inside the collar of her dress. After a minute she began to complain of feeling giddy and oppressed. Presently she manifested all the signs of incipient drunkenness—she was gay and disposed to sing. A little later she fell from the chair on to the floor in a state of complete inebriety, and with a simulation of the various stages of drunkenness so effectively dramatic that I doubt if any woman so uneducated could go through such a performance, except an hysteric of this class, when "sleep-waking" and freed from the restraint of the fully conscious action of the upper brain. It is this mixture of hysteria, partially numbed consciousness, trained automatism, and imposture, which so often takes in either the wholly credulous or ignorantly skeptical spectator. Of the imposture there was, as I shall presently show, *pace* the intelligent reporters, no doubt whatever. Nor do I doubt at any rate that this girl was a thorough-paced hysteric and trained hypnotic, and that she was in an artificially induced and pathological condition when she went through these elaborate and brilliantly performed antics. She was lifted into the chair and another hypnotized person placed alongside her in another chair. Their hands were clasped together. "We will now see," said Dr. Luys, whether "the vibrations will be communicated from one to the other," and the state of drunkenness transferred. So said, so done; and a similar performance, not, however, so skillfully executed, was gone through by the second and less experienced subject. On the following day we had yet a more picturesque performance. I was told beforehand that this was "the day of the cat," and that I might expect to see a highly trained sub-

ject who usually presented herself at the *clinique* on that day for what was commonly spoken of as "the cat performance." This was a Mlle. V., much described by Dr. Luys in his *Leçons Cliniques sur les Phénomènes de l'Hypnotisme.*

Of her Dr. Luys speaks as follows in his lectures to his pupils, to whom he presents her in set phrase as "an example of the degree of exaltation which memory and imagination may acquire in certain somnambulic subjects when other regions of the brain are in the condition of functional inhibition."

Here is Mlle. V., a professor of foreign languages, who is endowed with exquisite sensibility for hypnotic phenomena. For her, hypnotization has become an actual necessity, like morphine for morphinomaniacs. She is interested in all questions of this kind, for some time she followed punctually all the lectures which I gave here, and, as you will see, when I ask her if it interests her, she replies that she comes with pleasure, but she understands nothing about it; it is too technical. She only comes, she says, to assist in the experimental part of my lectures, and now when I question her she will tell you that she has not retained anything in her mind; that she has a very bad memory, and that she is incapable of giving the least account of the matter. That is what she is in the normal state, as you see, and you can accept the sincerity of her words. Now I will throw her into somnambulism, and you will see that the picture will change altogether. I say to her: "You are no longer Mlle. V., you are M. Luys, you are at the Charité, in his amphitheatre, and you are going to give his lecture on suggestion in his place." You see, she accepts my words with docility; she incarnates herself in my person; she takes my habits of language and of gesture, and, once started, you see with what facility, although a foreigner, she talks French, and with what correct sequence of ideas her explanations are given. She is never wrong; she finds the correct technical word; she varies her intonations, and presents really the innate qualities of a professor. More than that, you will now see a curious scene. I have a subject brought in and, placed in this arm-chair in front of her, tell her, "Here is a hypnotizable subject, whom you will send to sleep," and you will be surprised to see her repeat point by point the various proceedings for producing hypnosis; she explains to you accurately the symptomatic characters of lethargy, those of catalepsy, of somnambulism, in which state she is herself at this moment actually plunged, the different peculiarities belonging to these various states, details of the habits and manners peculiar to hypnotics, and, if I were not to interrupt her, she would go on talking thus for whole hours, until her strength was completely exhausted, and she would fall back again into lethargy.

This account of this remarkable person, which I had read beforehand, so much interested me that I was desirous to see her, and very sorry that she was not there on the usual day to play the cat. But not to disappoint us, the male patient, of whom I have spoken, was introduced in her place. He was rapidly hypnotized by holding a finger in front of his eyes, and when he had arrived at the proper stage Dr. Luys took out a tube and said, "We will try the valerian on him, but I am not sure it will succeed." The tube was, however, put inside his coat-collar in contact with his skin. Presently he became very uneasy, disturbed

in countenance, and moving awkwardly about in the chair. I asked him what was the matter. "He can not answer you," said Dr. Luys; "he is dumb, he can not speak; he is transformed; he is no longer a man and can not use the speech of men; he is assuming the nature of a cat." And, sure enough, presently the unhappy creature threw himself on to the ground with every sign of excitement and congestion; he began scratching about the floor on all fours, and presently mewing like a cat—a disagreeable but striking imitation—and when the valerian tube was taken from his neck and held in front of him he came scratching and spitting along the floor on all fours, as though irresistibly attracted, as a cat might be, to the person who held it. This astonishing gymnastic lasted for some minutes and seemed to fatigue him, as well it might. On the following day I secured the presence in my apartments of Mlle. V. above mentioned. On calling on her with M. Cremière I found her installed as a hypnotizer as well as a hypnotic subject, and with a plate on her door accordingly. We arranged for a *séance* on her usual terms. She insisted, however, on bringing "her subject" with her, for she apparently now finds the passive and performing state rather fatiguing and not sufficiently profitable, and prefers the *double emploi*. When she arrived a very amusing scene followed. Acting Dr. Luys to the life, she proceeded to place her subject before her, and began to give us the magistral demonstration based on his lectures on suggestion, which he describes above as the peculiar endowment of her somnambulistic condition, and of which, as he observes artlessly, he believes her to be quite incapable in her waking state, thinking it only possible when her faculties are peculiarly "exalted" by his manipulation. I have no doubt that, as he says, she would have gone on indefinitely and until she was exhausted; but we were very soon tired of her glib impudence, and stopped the performance after she had shown us how she had trained this new subject in three weeks to a number of the required manifestations. We had the "passional attitudes," "fascination," the *prise du regard*, etc. The eyelids were duly opened by order for further performances, for she intelligently observed:

The eyelids, gentlemen, are the windows of the soul, are they not? and in order that her heightened faculties may acquire their full perception, the light must penetrate; but she sees only me, she knows nothing of what goes on around her, she thinks my thoughts, she is *en rapport* with me alone.

Here we stopped her, for we were beginning to be fatigued, although she was not. We now requested herself to become the subject, and duly regretted her absence at the *clinique* of Dr. Luys on the previous day.

Oh (she said), I am very sorry I was not there, but I did not come because it is the off season. At the New Year every one is making holiday; very few peo-

ple come to the *clinique*, and there are not many strangers, and so I was told that it was not worth while my coming for the next week or two, and Dr. Luys did not expect me.

She then gave us a long list of her capacities, which run through the whole gamut of the phenomena described in the volumes of the professor at La Charité. She was duly put to sleep, and then I produced my tube. I had on the mantelpiece a number of tubes which I had taken at random from the laboratory of my brother-in-law, M. Vignal, containing a great variety of crystalline substances. These, however, she had already spied on the mantelpiece on coming in, and she said, "Oh, I must warn you that I am not at all susceptible to dry powders in tubes, only to fluids, and you won't get any effects with those." Respecting her scientific prudery and affected hypnotic exclusiveness, I humored her by immediately sending to the neighboring chemist for some tubes containing alcohol, valerian, cherry-laurel water, distilled water, and solution of burned sugar. One of the medical frequenters of the Charité was kind enough to go and get them, and he was good enough to see also that all the tubes were incorrectly labeled. A private mark on the corks indicated the true contents, which were duly entered in the notes of the sitting. I now said to him, "Kindly give me the valerian," in a low voice which she was supposed not to hear. This was duly placed in contact with the skin of the neck, the actual contents of the tube being *alcohol*. Then came the cat performance to perfection. I will do Jeanne (the other name under which this lady will be found spoken of in the lectures of Dr. Luys) the justice to say that she was by far the most accomplished performer of the three of his subjects whom I saw go through this performance at my rooms and at the Charité under similar circumstances. She scratched, she mewed to perfection, she washed imaginary whiskers, she spat, she licked her hands, she lapped milk from a saucer; and when you "pressed the button" at her back she sat up rigid as on hind quarters and caressed her face with her paws with a truly feline grace. She came back to her chair, or was supported back, for she was still supposed to be in deep somnambulism, and we brought into use the tube which was *labeled* cherry-laurel water, but which really contained valerian. Now commenced another performance, which among the trained subjects of the Charité is supposed to be identified with the "effect at a distance" of the fluid described on the label. After a decent period of waiting she fell slowly on her knees, her face assumed the characters of ecstasy, her eyes were fixed on space, and her features composed with great art to an affected expression of pious rapture; the hands were held up imploringly, then her head dropped and her arms folded across her breast as in prayer. Her hands presently were extended and her

face upturned as toward a vision of beauty, and she exclaimed in low and broken tones of rapturous emotion: "She comes, she comes; she is all in white!" and as this sacred vision died away her head dropped in solemn resignation, and after a short interval of resignation and grief the play was over, and she was brought back once more to her chair in a state of well-simulated lethargy. This same performance she repeated under similar conditions at the final *séance* at Dr. Sajous's rooms, where I organized a continued representation before a number of spectators by Jeanne, by Madame Vix, and Clarice, in all cases with tubes containing anything else but valerians. Clarice was a third subject who figures largely in the writings of Dr. Luys, and whom I met at his *clinique*. She also was for a long time a patient; she is a thorough hysteric and trained hypnotic, and she goes through some of these performances with even better grace and more seductive accomplishment than Madame Jeanne. We repeated with her twice all these performances, and also some others. For Clarice is now also a "professional"; she is younger and prettier, and charges a higher fee than that of the others; she has hypnotic specialties of her own. She requested that for the final *séance* she might be permitted to bring "her *pianiste*," for she told us that what she was particularly celebrated for were the beauty and grace of her *attitudes passionnelles*, which were best performed when the person who hypnotized her could play to her appropriate music, gay or melancholy. Accordingly, on the final occasion, she came with a pianist, who duly made a few customary passes, to put her into the somnambulistic state, then put her in the middle of the room and began playing suitable music. He supplied her with castanets, and she danced a gay and lively measure; he rose from the piano and took them from her, and then sad music threw her into attitudes of picturesque despair and delicately acted grief. We had no time to go through the whole performance, or I have no doubt it would have been well worth the money. I need not go through the entire category of proceedings. Prof. Luys told us that he had had as many as three of these people at once engaged in their cat performance, licking their paws, mewing, jumping, and scratching about the place; as he said, "un véritable Sabbat"—a true witches' Sabbath. He dwelt upon the importance of these manifestations (which he takes quite seriously) as opening up new realms of psychological inquiry. I quote from my notes:

Here (he said) is a new domain for psychical researches. It will enable us, at any rate, to catch glimpses of the animal mind, and perhaps to learn what they feel and think. I had a patient who in the somnambulistic stage was transformed into a cock and entered into the cock nature. I tried to make him remember when he awoke what he had been thinking of when he was thus trans-

formed, by ordering him to do so when still somnambulistic. I asked him what he had been doing. He said he had been crowing. I asked him why he crowed. He said he did not know, he crowed because he could not help it. I asked him what he had been thinking of, and his answer was, "Je pensais à mes poules" ("I was thinking of my hens").

This, however, appeared to be as far as we have yet got in this new excursion into psychical research of animals; it is not very instructive or edifying. So far as all these persons went they must be pronounced impudent impostors, and it is difficult to conceive how they can have succeeded in duping serious people, or how they can be permitted to have carried on the fraud for so many years. So also with the imaginary effects of the various medicinal substances in sealed tubes. I repeated this performance on every one of these five subjects of M. Luys, on whom he has for years been lecturing, whom he has photographed, and of whose good faith he gives so many assurances. We made notes (sometimes written by myself, sometimes by Dr. Sajous, sometimes by M. Cremière) of the results. The subjects were never once right, even by accident. When Mervel at the hospital supposed the tube to contain mercury although it really contained diabetic sugar, he suffered agonies of the kind which he supposed mercury to produce. He had gnawing pains; his limbs were being eaten away, and he was in dire agony from the worst effects which a prolonged mercurial course used often to produce, and of which the repute is still a tradition in the hospitals. Madame Vix, at my rooms, had another opinion of the effect of mercury, gathered apparently from its use in infantile ailments; for she was a mother. When she thought the tube contained mercury she began to suffer acute pains—"colique d'enfants," she said; and to stop the comedy I had to apply to her neck what was supposed to be a tube of cinnamon water, but which was really charged with bisulphide of mercury. This quickly calmed her pains, which were beginning to be indecorous. With Mervel at the hospital, when I had him to myself and hypnotized by the ward attendant, all the effects supposed to be due to valerian were produced with burned sugar. He was duly and quickly transformed into a cat, and the whole drama was enacted in the ward, but this time under the influence of a tube of sugar-water, with vivid feline effects. Strychnine, of which I was warned that the effects were most dangerous, for, as Dr. Luys observed to me, "You might kill a patient with it through incautiously applying the tube," I used repeatedly and most incautiously without producing any effects, for I was careful never to mention its name. I may emphasize that on this occasion it was not I who hypnotized Mervel, but a person who was well accustomed to do so.

Leaving now the detail of the various scenes of this tragi-

comedy, let us consider for a moment the interpretation of it and the lesson it teaches. It was not, I think, always and in all its stages wholly an imposture, although generally it was. Two at least of the subjects, Mervel and Marguerite, and, I think, perhaps Clarice, were pronounced hysterics and thoroughly trained hypnotics; they mingled pathological conditions and an artificially induced state of partial automatism with their abundant frauds. They were at once, as Voltaire puts it, speaking of like impostors, "duped and dupers, deceived and deceivers." Jeanne and Vix appeared to me from first to last to be acting a part with full consciousness of all their frauds. They were, moreover, anxious to accomplish them to my satisfaction, and in such a way, as they both openly stated, to procure from me what Jeanne called "a *réclame*" and Vix "the favor of my recommendation." After I was gone, Jeanne, the "professor of languages," and "sincere subject" of Dr. Luys's lectures, sent after me the following letter, which I think too interesting a document not to put upon record. I omit the address and the final paragraph, but I preserve the original spelling:

Monsieur le Docteur—Ayant eu l'honneur Samedie dernier de servir de Sujet à une Seance d'hypnotism chez vous, Monsieur le Docteur, j'espère que vous voudrez bien m'excuser, Monsieur le Docteur, la liberte que je prends de vous faire parvenir une petite nomenclature—des expériences et des phénomènes—que Mr. le Dr. Luys obtien, depuis bien tot 7 ans, sur moi.

1. On obtien sur moi tres facilement—
Les trois états classiques,
Léthargie, Catalepsie, Somnambulisme.

En Léthargie

Anestesie complète.
Tous les différents effects et contracture—au contacte—des differents Metaux.
Les Contractures Neuro-Musculaires.
Le jeu du Diaphragm.

En Catalepsie

Prise du regard—le point fixe—autométisme—les attitudes—Effets des Couleurs.
Suggestions par gestes.
Effets des Aimants.
Cessation du battement du poux.
Raideur cadaverique.

Somnambulisme

Tous les phénomènes de l'hyperestesie de la peau.
Les attractions.
Effects de medicaments à distance.
Suggestion—instantanée et à écheance.
Changement de personalité.
Mneumonie.

Vision.
Vue *absolue* à travers tous les corps oppaques sans *aucun secour des yeux.*
Double vue--transmission des pensées.

Voila Mr. le Docteur les phénomènes qu'on obtien très facilement sur moi—*sans jamais les râter.* Mr. Le Docteur Luys n'hésitera pas à le confirmer—d'ailleurs j'offre de le prouver—quand on voudra.

Je travail en ce moment comme Sujet (passif) à la Charité avec Mr. le Dr. Louys—et comme Sujet *active* avec mes sujets—chez moi tous les jours de 2 heures a 6 heures—et dans tous les Salons de la haute Aristocratie Parisienne en soirée hypnotique ou Spirite.

Anciennements Mdlle. . . . que Samedi Mr. le Docteur j'avais aperçue dans votre Salon *—á été employée par moi—pendant 8 mois *comme mon sujet.* J'ai été forcé de la conjedier pour un fait—assez sérieux. Cette petite dont les aptitudes sont absolument aussi nules que le Cabotinage, est grand profité des visites chez moi de quelques toutes jeunes dames du plus grand monde qui dans l'après midi venaient me consulter et naturellement en cachette de moi, pour grossire ces gages de sujet, cette petite fille sans conscience vendai de la morphine au morphinomane et de l'opiome aux opiomanes, une de mes cliente, Mme. la Vicomtesse de . . . devenue absolument opiomane par l'opiom procurai en secret par . . . a manque payer cela de sa vie. Par un hasard ayant deconvert la verite j'ai mise . . . immediatement à la porte. Voila pourquoi j'ai été desagreablement impressionée voyant cette triste personne singer avec aplond dans le salon de Mr. le Docteur tous ce qu'elle m'avais vu faire étant chez moi.

This document is perfect; its spelling, its jargon, its revelation of the under side of the genuine "marvels" of the new and old mesmerism, will make it historic.

We see here to what excesses this so-called science of hypnotism may lead, and we catch a glimpse, and only a glimpse, of some of its evil connections. The rest remain to be followed out, and ought to be followed out, by the Paris police, and no doubt the administrative council which presides over the hospital system of Paris will take some steps in the matter. It is hardly possible (except under a system of highly concentrated centralization, in which the true central governing body is so far removed from its peripheral members as to take little notice of what is going on there) that such things should happen or should continue. In any English hospital in which the controlling governors are on the spot, and the staff in habitual communication with them, such proceedings would long before have attracted inquiry, and would have been controlled. That is by the way. How much harm they can do in some directions, M. Luys knows very well and expresses very clearly, for he says in his lectures:†

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* This is another favorite subject of the Charité.

† Leçons cliniques sur les principaux Phénomènes de l'Hypnotisme dans leurs Rapports avec la Pathologie mentale. Par J. Luys. Paris: Georges Carré, Editeur, 58 Rue St. André-des-Arts, 1890.

From the social point of view these new states of instantaneous loss of consciousness into which hypnotic or merely fascinated subjects may be made to pass deserve to be considered with lively interest. As I shall have to explain to you later, the individual in these novel conditions no longer belongs to himself; he is surrendered, an inert being, to the enterprise of those who surround him. At one moment, in the passive stage in this condition of lethargy or of catalepsy, he is absolutely defenseless and exposed to any criminal attempt on the part of those who surround him. He can be poisoned and mutilated. Where a woman is concerned, she may be violated and even infected with syphilis, of which I have recently observed a painful example in my practice. She may become a mother without any trace existing of a criminal assault, and without the patient having the smallest recollection of what has passed after she has awakened. Sometimes, in the active condition, the state of lucid somnambulism, and even in the condition of simple fascination, the subject may be exposed to the influence of suggestions of the most varied kind on the part of the person directing his actions. He may be induced to become a homicide, an incendiary, or suicide, and all these impulses deposited in his brain during sleep become forces stored up silently, which will burst forth at a given moment with the precision, accuracy of performance, and automatic impetuosity of acts performed by the really insane. Gentlemen, bear this well in mind; all these acts, all these phenomena unconsciously accomplished are no mere vague apprehensions and vain suppositions; they are real facts which you may meet with this very day in ordinary life. They are apt to develop, and to appear around you and before you in the most inexplicable manner.

Of course the question will be asked, Are the practical uses or the applications of the artificial sleep (the induction of which is the residuum of this psychological puddle) of such value as to counterbalance its evils? As to its surgical uses, which at first sight are the most obvious, Luys himself says:

At the first appearance of hypnotism, when Braid had shown that hypnotized subjects are insensitive to external stimuli, surgeons conceived the idea of using this method for the performance of certain operations. In fact, some among them had the opportunity of testing it with a certain amount of advantage. But since the wonderful discovery of chloroform (and, it might be added, of local anæsthesia by cocaine, the vaporization of ether, etc.) these attempts, so far as concern surgical anæsthesia, have been justly abandoned. At the present time the application of hypnotism to surgical therapeutics is of absolutely no account, since it concerns only a small number of persons—namely, the class of hypnotizable subjects.*

In the domain of medicine M. Luys is naturally more hopeful and more affirmative; but obviously inspires less confidence than his calmer and more critical colleagues at the Salpêtrière, who have abstained from following him in these new developments and who regard them with disfavor and distrust. To me, the so-called medical cures by hypnotism seem to rank in precisely the same class as those of the faith-curer.

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* Applications thérapeutiques de l'Hypnotisme. Par le Dr. J. Luys. Paris: Imprimerie F. Lève, 17 Rue Cassette, 1889.

The hypnotic *endormeur* is very well able to explain the miracles of faith-cure and pilgrimage by the light of his own experience. They result, as he explains accurately, from the reaction of mind on body, the effects of imagination, of self-suggestion, or of suggestion from without. Those who benefit by them are especially the fervent and the enthusiastic, the vividly imaginative, the mentally dependent, and, above all, the hysterical—male or female. But clearly, the faith-curer may retort upon the hypnotizer that they are brothers in their therapeutic results, if not in their faith and philosophy. The one can work about the same percentage of cures as the other—and no more; and the intervening apparatus, whether of magnets, mirrors, or of grottoes, only serve to affect the imagination, and to supply "the external stimulus" which is necessary.

To this category belong also the long series of thousands of asserted cures of people who wear what they are pleased to call magnetic belts, or who used to wear magnetic rings, who were cured by the Perkins tractors, whether of wood or of iron—they are the prey of the quacks of all ages and countries.

One essential part is, however, I conceive, that no new faculty was ever yet developed in any of these hypnotics. The frauds of clairvoyance, of spirit perceptions, of gifts of language, of slate-writing, of spirit-writing, of far-sight, of "communication across space," of "transfer of mental impressions," of the development of any new sense or ghost of a new sense, remain now as ever, for the most part, demonstrable frauds or perhaps in a few cases self-deceptions. At the Salpêtrière, at Nancy, wherever the facts have been impartially and critically examined, this has been the result. It results once more now from my test of the subjects of the Charité and the École Polytechnique. It will, I suppose, be too much to expect that we shall hear no more of the "New Mesmerism," but it will be easy for any one thus experimentally to reduce it to its true dimensions.

Finally, as to the practical question, which has perhaps a greater interest for the sociologist than any which have suggested themselves up to this point. Since the hypnotist faith-curer of the hospital ward and the priestly faith-curer of the grotto are in truth utilizing the same human elements and employing cognate resources, although masked by a different outward garb, we may ask ourselves which can approximate to the greater successes and which does the least harm.

So far as I can see, the balance is in favor of the faith-curer of the chapel and the grotto. The results at least are proportionately as numerous, and they are more rapid. Numerically there are, I incline to think, more faith-cures at Lourdes than there are "suggestion-cures" in the Salpêtrière or the Charité. So far as

hypnotism is good for anything as a curative agent, its sphere is limited, by Charcot, Féré, Babinski, and all the most trustworthy medical observers of Paris, to the relief of functional disorder and symptoms in hysterical patients. The Nancy school put their pretensions higher; but any one who will analyze for himself, or who will study Babinski's able analysis of the Nancy reputed cases of cure, will easily satisfy himself that such claims are not valid. As to the use of "suggestion" as an anæsthetic substitute of chloroform for operation purposes, that "sugges ion" dates back now beyond the ages of Esdaile and of Elliotson. It has been given up and fallen into disuse because of its unreliability and limited application. It is now sagely proposed to use hypnotism for "tooth-drawing," for the treatment of drunkards and of school children. The proposition is self-condemned. To enable a dentist to draw a tooth painlessly, the average man or woman is, by a series of sittings, to be reduced to the state of a trained automaton; but happily only a very small proportion can be. The criminal courts have seen enough of hypnotic dentists. As to the "suggestion" cure of drunkards or the "suggestion" treatment of backward or naughty children, systematic and intelligent suggestion is what every clergyman, every doctor, and every schoolmaster tries to carry out in such cases and often does successfully—and in a better form than the degrading shape of hypnotism. Moreover, for drunkenness it is, so far as my inquiries go, a failure.

If a striking effect is to be produced by an apparatus destined powerfully to affect the imagination, the faith-curer of the grotto has this advantage over the *endormeur* of the platform or the hospital. He does not intrude his own personality and train his patient to subject his mental *ego* to that of his "operator." The "mesmerizer" seeks to dominate his subject; he weakens the will power, which it is desirable to strengthen. He aims at becoming the master of a slave. I do not need to emphasize the dangers of this practice. I need not even relate them. I have briefly quoted the warnings of one of its apostles, or at least so much of them as it is seemly here to relate.

The faith-curer of the grotto strengthens the weaker individuality. He plays upon the spring of self-suggestion. The patient is told to believe that he will be cured, to wish it fervently, and he shall be cured. So far as he is cured, he returns perhaps a better and a stronger man, and his cure is quite as real and likely to be quite as lasting as if he had become the puppet of a hypnotizer. The experiments of the Salpêtrière have served to enable us to analyze more clearly the nature of faith-cures generally, and they have thrown a ray of light on a series of phenomena of human automatism never before studied so clearly or

philosophically, but they have added practically little, if anything, to our curative resources. It is hardly to be set down to their discredit that they have incidentally favored the reign of the platform hypnotizer or the vagaries of the subjects at La Charité; that is their misfortune rather than their fault, but it is a grave misfortune. But the intervention of authority might at the present, in respect to the latter, cut short these absurdities and put an end to some social mischiefs which have fastened on to them and hang to their skirts. Thus much as to the sociological question. To the student of "psychological phenomena" it has a great interest to note how successive functions may be separately abolished as the brain is partially set to sleep, and in what exaggerated forms the remaining activities may be brought upon the stage when restraining self-consciousness is stilled. The vulgar, too, may find an ignoble amusement in the antics of these drinkers of petroleum and vinegar, in the semi-idiotic postures and proceedings of the hypnotized manikin, as they do in a *fantocchini* show or a puppet play. But against such philosophic satisfactions and vulgar amusements must be set the avowed and the unconfessed mischiefs, and who can doubt that these outbalance any good result which can be discerned?—*Nineteenth Century.*

[*Concluded.*]

SOME REMARKABLE INSECTS.

By WILLIAM J. FOX.

THE great majority of persons have no idea of the numerous and singular forms of insects. They are all called "bugs" by most people, yet not one tenth of their number are really bugs. These latter are classed by themselves and are called *Hemiptera.* Beetles are not bugs, being totally different things, and form what are known as the *Coleoptera,* which means sheath-wing, because of the two large plates on the back that cover the true wings, which consist of thin membrane. These covers are called elytra. The butterflies and moths form another one of these orders, being called *Lepidoptera,* or scale-wing, on account of the tiny scales with which the wings are covered. No doubt many of the readers of this article have noticed the powdery substance which comes off a butterfly or moth on handling it. These are the scales, and, should any reader possess a microscope and place the wing or part of one under it, I think he will be repaid for his trouble. The "dragon flies" and "devil's needles" form the order *Neuroptera,* which means vein-winged. So it is with the flies and the

bees, wasps, and ants, the flies being called *Diptera*, i. e., two-winged, and the bees, wasps, and ants, *Hymenoptera*, or membrane-wing. It will probably be said by some that ants have no wings; but this is only the case with what are called neuters or workers, the males and females being provided with wings. The total number of different kinds of insects that are known at present is over two hundred thousand, of which beetles alone number one hundred and twenty thousand — this being about twice as many as all the other known animals together. It is estimated that the actual number of different kinds of insects in the world is over one million.

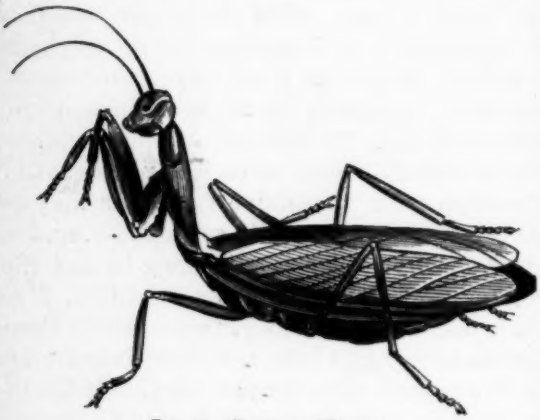

FIG. 1.—PRAYING MANTIS.

The *Orthoptera*, to which grasshoppers and roaches belong, present many oddities; foremost among them, in the United

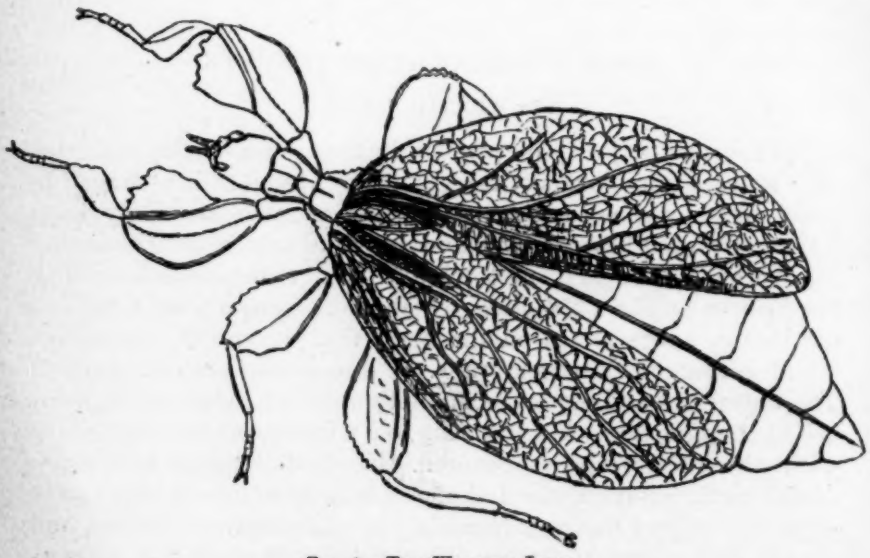

FIG. 2.—THE WALKING LEAF.

States, is the mantis or "praying mantis." It is very common throughout the South. It will be seen that the fore legs are armed

with strong spines or teeth, used for securely holding any insect that may fall into its clutches. I have seen this insect leisurely devouring flies held between these legs. From it there was no chance of escape. A specimen observed in captivity washed itself in the same manner as a cat, rubbing its head and face with its fore legs. In South America a species of mantis is said to seize and devour small birds.

FIG. 3.—NEMOPTERA COA.

Another strange orthopter is known as the "walking stick," which so closely resembles the stems of plants upon which it lives that it is very difficult to find them. One species (*Diapheromera femorata*) is abundant in the Middle States. This species is green when the foliage upon which it lives is of that color, but when this changes in the autumn the color of the walking stick changes also. It is said to do great injury to oak and other trees.

In the East Indies is found an insect that greatly resembles a leaf, both in form and color, as will be seen by the figure on page 528. It is very appropriately called the "walking leaf," and is known to scientists as *Phyllium siccifolium*. There are about a dozen species of these insects known, all of which are from the Oriental regions.

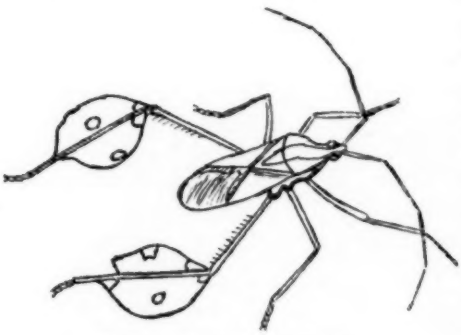

FIG. 4.—DIACTOR BILINEATUS.

In southern Europe there is found a peculiar insect that belongs to the *Neuroptera*, the same order as do the "dragon flies," "devil's needles," "snake doctors," etc. The scientific name of this insect is *Nemoptera coa*. It will be seen that the first pairs of wings are very broad, but this is not the peculiar part of it; it is the hind pair that are remarkable, being extremely long and narrow and a little broader toward the end, which gives them the appearance

of paddles. There is nothing more in this group of insects that is very striking.

We will now take up the *Hemiptera*, of which the well-known bedbug is an example. One species from tropical America (the *Diactor bilineatus*) has very slender legs, except the tibiæ of the hind pair, these being broadly expanded. What use these expansions are to this insect is not known.

FIG. 5.—RANATRA FUSCA.

Another singular species, one that is found throughout most parts of the United States, namely, *Ranatra fusca*, inhabits ponds and other streams. It is known to destroy the eggs of fishes and to attack young fish. It is when they attack fish that their stout fore legs come into play, being used for grasping and holding any unfortunate fish that should fall within their reach. It will be seen how well adapted these legs are for the purpose.

Among the beetles, or *Coleoptera*, there are many curious forms, of which I will only mention a few of the most prominent. *Acrocinus longimanus*, the "long-armed" beetle, as it is called, has the fore legs greatly elongated, being twice as long as the body and about three times as long as either of the other legs. It inhabits tropical America, where it is said to be quite abundant.

The giants among insects belong to the genus *Dynastes*, and to several allied genera. Of *Dynastes*, one (*D. hercules*) found in

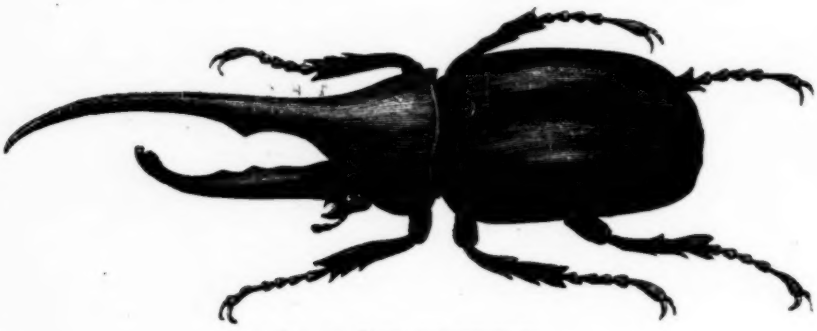

FIG. 6.—DYNASTES HERCULES.

Africa attains a length of six inches, and is remarkable, not only for its great size, but for the long, curved horn which projects out from the thorax; beneath this horn there is another much

shorter one, which projects from the head, being armed with several huge teeth. Insects of the male sex only are provided with these immense horns, those of the opposite sex being quite a different-looking beetle, being without any trace of these projections. There is a species that inhabits the southern United States that also belongs to this genus, but it is much smaller, being about two and a half inches long.

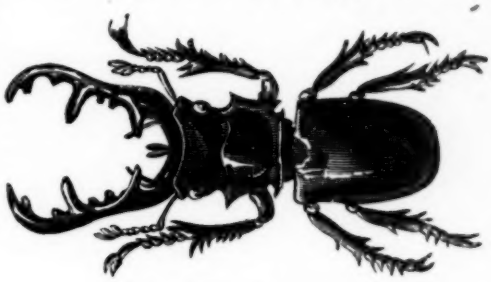

FIG. 7.—STAG BEETLE.

The "stag beetle" of Europe is another strange form, the mandibles of the male being greatly enlarged. From the shape and size of the jaws one would suppose that this insect is predaceous, but it is on the contrary a vegetable feeder, using its great jaws to wound the plant, which causes the sap or juices to flow, upon which it feeds. The jaws of the females are in no way conspicuous. There is also a closely allied species found in the United States, but it is a smaller insect. Many other curious forms are found among the beetles, but they are too many to mention.

FIG. 8.—DEAD-LEAF BUTTERFLY.

The *Lepidoptera*, or butterflies and moths, have a few odd forms among them. One of the most interesting is what is known as the "dead-leaf" butterfly, found in the Malay Archipelago. The under side of this butterfly greatly resembles a dead or dried leaf, so much so that it is next to an impossibility to detect it when it alights among withered bushes. Wallace, in his book The Malay Archipelago, says of this insect: "Its upper surface is of a rich purple, variously tinged with ash color, and across the fore wings there is a broad bar of deep orange, so that when on the wing it is very conspicuous. . . . I often tried to capture it, without success, for, after flying a short distance, it would enter a bush among dead or dried leaves, and, however carefully I crept up to the spot, I could never discover it until it would suddenly

start out again and then disappear in a similar place. At length I was fortunate enough to see the exact spot where the butterfly settled, and, though I lost sight of it for some time, I at length discovered that it was close before my eyes, but that in its position of repose it so resembled a dead leaf attached to a twig as almost certainly to deceive the eye when gazing full upon it." In tropical America there are a number of species that have wings so transparent that it is possible to read small print through them. Among the moths the "death's head" of Europe is remarkable for having on the top of the thorax the figure of a skull and cross-bones. It is an object of great terror to the ignorant classes, and it is said "has more than once thrown a whole province into consternation, the people thinking it was some infranatural being sent upon the earth as a messenger of pestilence and woe."

FIG. 9.—UMBRELLA ANT.

The *Hymenoptera*, which include the bees, wasps, and ants, contain a number of interesting forms, especially among the ants. The "umbrella ant" of Brazil has a tremendous head in proportion to its body, as will be seen by the figure. It has received the name of the umbrella-ant because of its habit of cutting out round pieces of the leaves of orange and coffee trees, which it carries by its jaws in an upright position, so that it looks as though it were utilizing its burden to keep off the heat of the sun.

The "driver ant" of Africa, the sting of which is compared to the thrust of a red-hot needle, is another interesting subject. These ants are totally blind, and, when an army of them gets on the march, all animal life in their path gets into activity, for woe to any living creature of small and even large size that should fall into their power! They also enter houses, driving the inhabitants from them, but on the return of the latter, after the ants have left, they find their place of abode cleared of all vermin; rats, mice, and all other pests of the house are destroyed by these scavengers. The largest serpents, if gorged, will fall a victim to these remorseless creatures. They have been known, when a stream interrupts their journey, to actually link themselves together and form a floating bridge, over which the

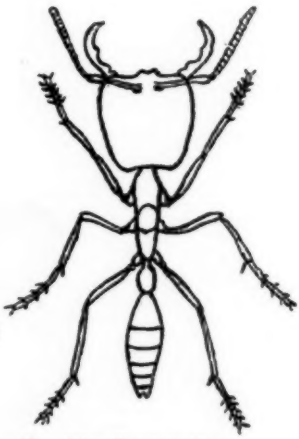

FIG. 10.—DRIVER ANT.

rest of the army passes. When a stream is too rapid for such a bridge, they form a suspension bridge by hanging from a friendly branch, and when wafted across by a breeze, they firmly anchor on the opposite shore, thus allowing the rest to cross in safety, and swing over themselves when the others have all crossed.

THE MATERIAL VIEW OF LIFE AND ITS RELATION TO THE SPIRITUAL.

By Prof. GRAHAM LUSK,
ASSISTANT PROFESSOR OF PHYSIOLOGY, YALE MEDICAL SCHOOL.

WE live in a material age. Old beliefs are being supplanted by what seem to be new truths. The student finds on every hand vast volumes of learning bequeathed to him by those who have labored before him; and he who plunges deeply into this onward-rushing tide of material truths is often startled to find there an undertow sucking away the spiritual foundation. Skeptics, in scorn of latter-day religion, refer to the middle ages as the ages of faith. Christians, half dismayed, ask themselves, Is mankind to be swallowed up in the abyss of materialism?

It is the purpose of this paper to discuss life from a strictly material standpoint, and afterward to show that belief in the material interpretation does not cut one off from belief in the spiritual.

My own ideas have been largely influenced by German thought. Those who have had the privilege of listening to the lectures of Prof. Carl Voit in Munich will recognize in this paper many traces of his teaching. Through him I received instruction in the material view of life.

The idea of the world held by Aristotle was that all things were made up of certain elementary matter, qualified by four properties—hot, cold, wet, and dry. Matter, with the properties cold and dry, was earth; with cold and wet, water; with hot and wet, air; and with hot and dry, fire. Different bodies varied from each other as they contained different proportions of the properties. These properties could be driven off from matter—that is to say, were separable from matter. Thus, the alchemists of the middle ages thought if they could drive a certain property out of mercury, or put a new one into it, clearly they would produce gold.

In like manner these same principles came into use for the explanation of life. During life there was a property present which departed at death—a living principle, a "vital force."

Galen, who was born at Troy, and who died at Rome A. D. 200,

applied the learning of Aristotle to his practice of medicine. Man, he said, is but matter containing certain properties. If these properties be in correct proportion, well and good; but if the balance be upset, sickness results. The therapeutics of Galen consisted, therefore, in restoring the lost property. If the patient had a chill, he put him in a warm bath; if he had a fever, he put him in a cold bath.

Van Helmont, whose work belongs chiefly to the first half of the seventeenth century, tells us of the existence of an Archæus, and in this theory he was supported by Paracelsus. The Archæus was a spirit which had its abode in the stomach of man. If the Archæus were well nourished, he was pleased and happy; but if anything disagreeable reached him, he made his displeasure painfully evident, and if something were not done to appease his anger, he betook himself off, and the man was dead.

Our present views are entirely different. Properties are not separable from matter. Properties are inherent in matter. Upon this knowledge our modern opinions are based. We have spoken of a belief that life depended on a property—a "vital force." A "force" may be defined as something that can not be explained. The laws of gravitation stand as Newton left them, but what the force of gravitation is no man can say. Hence, the expression "vital force" was but a confession of ignorance. No, there is no such thing as a "vital force." There are in living Nature and in the inanimate world the same materials, ruled in both cases by the same natural chemical and physical laws, only the conditions in living Nature are different from the conditions in the inanimate, and consequently the phenomena observed are likewise different.

Let us now look at some of the discoveries which have caused us to accept this material view of life.

Harvey, in 1616, first taught the true doctrine regarding the circulation of the blood, and compared the heart to a pump.

Scheiner, a Jesuit priest, declared the action of the eye to be like that of a *camera obscura*, the lens of the eye acting to form a picture on a background.

Keppler developed the theory of spectacles.

Borelli explained how the mechanism of breathing was due to the elasticity of the lungs and to the muscles acting as power upon levers—the ribs.

Lavoisier showed that animal heat was due to the decomposition of higher chemical compounds of the food eaten, just as the heat of the candle is produced by the combustion of its constituents.

All these facts are easily seen to be but followings after Nature's laws. Chemistry brings many proofs confirming the doc-

trine that there is no fundamental difference whether of properties or of governing laws between the animate and the inaminate. The chemist turns starch into sugar in the laboratory; the intestines do the same.

We find at the beginning of this century a theory supported by Lavoisier which declared that, to form an organic compound, life was necessary. The organic compounds had properties essentially different from the inorganic or mineral, and were formed under different influences—under the influence of a "vital force."

The greatest blow to this theory was the discovery by Wöhler, in 1828, that he could make urea in the laboratory. Here, then, was a characteristic animal substance, which was actually formed in the laboratory without the intervention of any "vital force" whatever. Since Wöhler's discovery an overwhelming number of similar bodies have been formed in like manner. Sugar may be made from its elements—carbon, hydrogen, and oxygen. There is little doubt that at some future time the method of making all the materials of any organization will be known to the chemist.

It has been said that organic materials are more easily decomposable than inorganic; but albumen, if dried, will keep for years, whereas silver iodide on the sensitive photographic plate is changed by light in the hundred-thousandth part of a second.

Hence, it is not difference in materials that can distinguish the organized from the unorganized. Indeed, every organization consists in major part of water, which is inorganic, and every organization must contain salts. In both organic and inorganic we find crystals; white of egg has already been crystallized. In fact, there is no boundary to be drawn. Over the organic and inorganic rule the same natural laws. The distinction is merely conventional.

The difference between the organized and the unorganized does not lie in the materials represented, only in the *arrangement* of the materials. The element of life is the minute cell. All life in the organization is dependent upon the activity of the cells. I have said that the conditions in the organized were different from those in the unorganized. The cell furnishes the conditions for life. Now, the arrangement of the materials in the cell is different from that in unorganized matter. In the piece of copper or crystal of sugar the smallest particles are everywhere the same. In the living organized cell the smallest particles are everywhere different. Such arrangement of materials that the conditions for life are present is the so-called protoplasm.

The yeast cell is a microscopic sausage-shaped organization which, under proper conditions, changes sugar into alcohol and carbonic acid. This is a characteristic function. In the same manner the cells in the body have their characteristic functions in decomposing the materials furnished by the blood.

The living cell is made up of organic and inorganic constituents. It contains carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, chlorine, sodium, potassium, calcium, magnesium, fluorine, silicon, and iron. All these are necessary to life. Abstraction of one of these elements means death to the organization.

We have traced life down to the cell. The lowest forms of life, both animal and vegetable, are single cells, and from these single cells, according to the theory of evolution, all life has been produced. But how about the origin of the first cell? We do not believe in spontaneous generation—that is to say, no case of the spontaneous generation of life from its elements has ever been recorded by man. But we may reason thus: All substances, even the simplest, require certain conditions for their production. The conditions required to produce a living cell must of necessity be extremely complicated. We do not know of such conditions, but for the sake of argument we may imagine that at some former period of the world's history conditions may have existed favorable to the production of the first life.

When we seek to define life we uncover a difficult problem. But who can define the steam engine? There is no satisfactory definition for either. We can merely say that life is the result of the activity of the cells.

It follows from this that it is useless to seek for a seat of life. The seat of life has been placed in the blood, but this is the nourishing fluid; in the heart, which is merely the pump for the blood; in the *medulla oblongata*, but this contains the nervous center for breathing. There is no such thing as a seat of life. Life is the result of the activity of all the organs of the body.

To every living thing there at last must come an end, and in this fact of death the advocates of a "vital force" saw the necessity for their theory. But this is explicable in a material manner. In life, as in death, decompositions are continually going on. These decompositions are in kind not different, only during life the products of decomposition are removed, and at death these products remain in the body and poison the individual cells—that is, so alter them that their conditions no longer fulfill the requirements of life.

The uneducated Indian when first shown a watch thought that it was alive; we, on the contrary, have come to regard the living organization as a machine. Upon this basis alone can physiology endure as a science, and physiology is, as the reader knows, nothing but the study of the phenomena of life.

I have endeavored, up to this point, to give an exposition of the material view of life as complete as the most exacting materialist could desire. Many men reach this point and refuse to see further; they make materialism their creed, and cast religion to

the winds. Now, is this rational? Is it impossible for the scientific mind to conceive of the existence of the soul? Certainly not.

When we seek for explanation of intellectual activity we find two views advanced—one, the purely material view that all thought comes uncontrolled from the decomposition of matter, from motion in the molecules; the other, the spiritual view that mental activity is under the domination of a soul. Under no circumstances can the soul be in a position to produce something out of nothing; it must rather, in the production of thought, utilize the materials furnished to the brain by the blood. The existence of the soul has never been scientifically proved; on the other hand, no material thinker can pretend that the purely material view explains the phenomena of intellectual activity. Let us see, therefore, if we can not employ some reasoning in support of the spiritual view, which declares the existence of the soul.

Matter is divided into ponderable and imponderable—ponderable, that which can be weighed; imponderable, that which can not be weighed. We place a body under the bell jar of an air pump and exhaust the air; all the ponderable air is thus removed. There still remains the imponderable ether. On this ether light-waves travel, and the object in the *vacuum* therefore continues visible. Here, then, is a something in the *vacuum* which is invisible, imponderable, and yet whose existence is scientifically acknowledged as pervading all space. This ether is set in motion by the vibrating object we have under consideration; this motion is communicated to the nerve endings on the background of the eye, travels thence along the nerve, and produces in the visual sensorium of the brain the sensation of what we call light. The existence of this ether has never been scientifically proved, but it gives an explanation to something otherwise inexplicable.

A man dies; the spirit passes from him; the flesh is left. The man has not lost in weight; the spirit is imponderable. Now, as there is a connection between the luminiferous ether and the nerve endings for sight, why can not there be a connection between the spirit and the countless mass of cells and fibers where is what we call the intellect? And, likewise, may there not be a spiritual ether surrounding us, a medium through which impulses may come to the spirit from on high, and from the spirit be transmitted to the intellect? Such influences come to us strongly at times, as at the communion-table. The existence of the soul, I have said, has not been scientifically proved, but it is the explanation of something otherwise inexplicable.

We gain our experience of the world through our senses. Man is born with intellect, and through the senses that intellect is trained. The newborn baby possesses already some knowledge of touch acquired before birth, and this knowledge he afterward

rapidly expands by constantly feeling his body over and over, as if in exploration of unknown territory. Later he acquires the faculties of hearing and seeing, and likewise of tasting and smelling. Now, these senses, five in number, are they which train the intellect. They are all very imperfect. Sight: but the greater part of the solar *spectrum* is invisible—that is to say, more rays which come to us from the sun are invisible than those which our eye can see. Hearing: but there are sounds so low and sounds so high that they are inaudible. Taste and smell: very imperfect. Touch: but there are millions of particles of dust to the square inch of the hand which we can not feel. Yet, even with these imperfect means of education, many men have reached the conclusion satisfactory to themselves that they are clever; but the wisest man knows nothing in comparison with perfect wisdom.

The whole of the known universe consists of matter in motion. All sensation, everything we know of the outside world, comes to us through motion. The motion sets up a movement in the nerve ending, on the skin, on the retina of the eye, or wherever the proper ending capable of receiving the particular motion may be situated. This motion is carried from the nerve ending along the nerve to the special central organ of the brain where it is interpreted. Light, sound, touch, taste, and smell are the only forms of motion we are capable of appreciating, because for each of these forms of motion we have a special apparatus which can receive, transmit, and interpret. There are other forms of motion which we can not appreciate—magnetism, for example—and this simply because we have no nervous mechanism which responds to that kind of motion. In like manner there can exist around us forces in infinite variety of which we have absolutely no knowledge whatsoever.

Now, is it not conceivable that, in the spirit after its severance from the flesh, our present imperfect senses may become perfect, and the influence of other now unthought-of sensations become possible? What the new sensations and the new life will be are unknown, unknowable. A man is born blind. He attains through touch, hearing, and the minor senses a certain amount of knowledge of the outside world, but his ideas of what really is must of necessity be absolutely and entirely different from our own. The operation for cataract is performed; the man can see, and is shown a familiar object—a book for example; but he can not say what it is; he must touch it first. His ideas of things undergo an immediate and radical change. So it will be at death with our ideas of heaven. The blind spirit, released from the influence of the flesh, passes into perfect understanding of infinite knowledge.

To my mind, the material view of life should have no terrors to believers in religion.

SEALING IN THE ANTARCTIC.

By a Member of the Recent British Whaling Expedition.

A LAPSE of nine months has brought back the Antarctic Whaling Expedition. It will be remembered that in September last four ships—the Balæna, the Diana, the Active, and the Polar Star—set out from Dundee to try their fortunes in the south polar seas, since of late the Davis Strait and Greenland fishing has not met with entire success. The expedition was to try to obtain a whale which Sir James Ross described as "greatly resembling and by some said to be identical to the Greenland whale," and was to restrict its researches to that region visited by Ross in his third voyage to the Antarctic in the summer 1842–'43. At the request of the Royal Geographical Society and of the Royal Meteorological Society, it was arranged that the medical officers accompanying the expedition should, under the guidance of the masters and with the assistance of the other officers, make such scientific observations as were compatible with an expedition so purely commercial in character. With this understanding these two societies gave a grant of instruments which Mr. Leigh Smith and others liberally supplemented with other scientific outfit. Naturally, therefore, among scientific circles a certain amount of chance scientific work is being looked for. The expedition has added considerably to our knowledge of the meteorology of the southern end of the globe and has noted geographical and other features. But, on account of the overwhelming commercialism of the expedition, opportunities, which might have been taken advantage of, have been allowed to pass.

Owing greatly to the hurried departure of the expedition, much setting in order of material and seeking out of information regarding these scarcely known parts employed a considerable amount of time on the passage out, and systematic meteorological observations were commenced from the outset; tow netting and other collecting was reserved for latitudes south of 40° south, and for the homeward voyage, for it was deemed unwise to occupy space and make use of preservatives which might be required for material obtained in high southern latitudes. Nevertheless, on the passage out, it was thought advisable on a few occasions to take a cast of the net. For the whole outward passage, with the exception of a few days in the southeast trades, the ships were baffled by head winds, for nearly three weeks we wished our native shores more distant, and for fifteen days the Roaring Forties racked us with southwest gales. We experienced heavy squally weather, with frequent lightning and heavy rain. The *maximum* temperature of the air was 83° Fahr. on the 23d and

24th of October, in 3° 56′ north, 25° 15′ 15″ west, and 2° 33′ north, 25° 37′ west respectively, and from the 17th to 22d, 25th, and 31st October and the 2d November the thermometer registered 80·8° to 83°.

On the 8th of December the rising sun dispersed a dense fog and revealed the rugged shores of West Falkland, the first land we had seen for three months, and in its likeness recalling the last glimpses we had of Cape Wrath. By noon we had dropped anchor, and during the next few days, while the ship was being stocked with a supply of fresh meat and water, the surgeons of the vessels were able to make one or two short excursions. These excursions, however, had to be extremely brief, for not knowing when the ships would depart it was necessary to remain in sight of them the whole time. A few plants, stones, and insects were hastily gathered together, and several birds shot. Among the latter were the notable steamer duck and the upland goose. A striking feature of the Falkland Islands is the great absence of trees; the camp, as the open country is termed, is clothed with a short scrub called diddle-dee (*Empetrum rubrum*), growing upon and indeed chiefly forming the enormous peat-beds that this country is so rich in; the largest bush native to the country is the gigantic woolly ragweed, which grows to a height of three or four feet; but there are few flowering plants. The gorse or furze has been introduced and seems to thrive well, but a few trees that have been planted about Stanley present a meager appearance. Mosses and lichens abound everywhere and many of the lichens are very beautiful. Besides the above-mentioned, one must note the ever-famous balsam bogs and tussock grass, and the enormous banks of kelp that fringe the coast, the stems of which vary in length from five to forty feet. Among birds, the penguins and albatross must not be forgotten. Insects are rare. The famous wolf-like fox is almost extinct; Darwin's prophecy is coming true—the wild horses and cattle now no longer roam the plains, their place having been taken by the more remunerative sheep. The fur-seal is still found, but so eagerly have they been hunted that their numbers have been greatly reduced. A solitary lizard and a few insects almost complete the list of animals found in these islands. One must ever remember the world-renowned streams of stones and the characteristic quartz rocks cutting their way through the quilt of peat. But Darwin, Hooker, and others have so ably pictured the natural features of the Falkland Islands that it would be out of place to describe them again after so short a visit. There is a great change, however, since Darwin's time—he found it a settlement of thieves and murderers, now it is a peaceful British colony, for, after a disputed possession of the islands by Britain, Spain, France, and Buenos Ayres, Britain finally took

possession of them in 1833 and formed a colony which is now ruled by a governor and is also the see of a colonial bishopric. The colony at first was far from prosperous, but since 1885 the revenue has considerably exceeded the expenditure. During our stay at Port Stanley his Excellency the Governor honored our ships with a visit, as well as several of the residents of the settlement, and we are greatly indebted to his Excellency and Lady Goldsworthy for the hospitality they showed us.

Early on Sunday morning we took leave of the Falkland Islands and steered for the ice, and on December 16th, in latitude 59° 18′ south, longitude 51° 01′ west, met the first iceberg—it was of enormous dimensions and tabular; a second was sighted in the evening. The same day we met myriads of cape pigeons, also many blue petrel and molly-hawks. The sea was literally swarming with whales of the finner kind, and their resounding blasts could be seen on all sides. So numerous were the cape pigeons, and so eager were they for any scraps thrown over the ship's side, that any number of them could have been caught with small hand-nets only large enough to contain one at a time, and many of them were thus captured by the crew. That night it became overcast and rainy, and at midnight a fog came on; fogs continued, with shorter intervals of clearer weather, during which intervals we were able to push southward for the next few days, and the weather was squally, the wind being from northeast, north, and northwest, varying in force from a light air to a moderate gale. After six days of this inhospitable weather, the wind on the afternoon of December 22d shifted more to the south, and the fog quickly lifted. On December 17th we met with the first seal—it was one of the larger kind which Ross described, nearly twelve feet long, having a bearlike head, with formidable canine teeth; it was curled up and asleep, and it was drifting by as we lay in the fog. It was promptly shot and brought aboard by a boat lowered away for the purpose. Several pieces of drift ice were seen on the 17th of December, and several bergs, nearly all flat-topped. On the evening of the 22d we first met with a flock of ten or a dozen of the beautiful sheathbill, and on the morning of the 23d sighted and passed the group of Danger Islets, lying off the extreme west of Joinville Land, which was lying behind them. The sea in the evening became of an olive-brown color, and we met with the snowy petrel, two indications which Ross noticed of the main pack being at hand. On the following evening three of the Dundee ships made fast to a very large floe. On Christmas day observations were taken, and it was found that we were a little south of Ross's position on New-Year's eve of the summer of 1842–'43—viz., latitude 64° 13′ south, longitude 55° 52 west, and where he says "great numbers of the largest-sized black

whales were lying upon the water in all directions; their enormous breadth quite astonished us. The color of the sea was a dirty brown, probably occasioned by minute ferruginous infusoria, which were found in the greenish-colored mud that was brought up by the deep-sea clams from a depth of two hundred and seven fathoms." The sea was as Ross describes it, and soundings were obtained at 8 P. M. in one hundred and ninety-four fathoms, but no black whale did we see, only whales with fins on their backs, but be it noted that several grampuses or killers were seen from the masthead, and they are noted persecutors of the black whale in the north.

Up to this time several seals had been obtained—the large seal, the white antarctic seal, and the sea leopard; also four different kinds of penguins, including a few of the large emperor penguins, and one seen in the neighborhood of the Falklands. Besides these, we had met with a good many sheathbills, several snowy petrel, the blue petrel, the giant petrel, the stormy petrel, the cape pigeon, a gray gull, and later with many terns and a few great petrel. Christmas eve and Christmas day, when we were fast to the floe, will long be remembered by the members of the expedition. There was a perfect calm; the sky, except at the horizon, had a dense canopy of cumulus rolls, which rested on the summits of the western hills, and when the sun was just below the horizon the soft grays and blues of the clouds and the spotless whiteness of the ice as it floated in the black and glossy sea were tinted with the most delicate of colors—rich purples and rosy hues, blues, and greens, passing into translucent yellows. At midnight the solitude of the vacant deck was grand and impressive, and perhaps more so since we had, for well-nigh a week, been drifting among bergs with dense fog and very squally weather. Nothing broke the calm peacefulness; now a flock of the beautiful sheathbills would hover round the vessel, fanning the limpid air with their wings of creamy whiteness, and over yonder was a foul carrion bird with outstretched wings feeding upon the gory corpse of a slaughtered seal. All was in such unison, all in such perfect harmony; but it was a passing charm. Soon we had to think of more prosaic things, and reluctantly we turned our thoughts to the cargo we were to seek. It was with the produce of seals that we were destined to fill our ship, and till February 17th we were literally up to the neck in blood. All the sails are stowed; the captain sits in the crow's nest from early morning till late in the evening; the two engineers, relieving one another, take charge of the engines; the cook or the steward is on the lookout on deck or on the bridge; and the doctor takes the helm, unless he can manage to get away in the boats, in which case some other noncombatant has to take his place—all the rest

are away after plunder. Now a full boat is making its way to the ship. We steam toward her. As we near, the engines are stopped and she glides alongside. The cook or the steward rushes from the lookout, the doctor from the wheel, one working the steam winch and the other unswitching the skins, while the boat's crew swallow a hasty meal. The boat being unloaded, they are off again for another fill. The greatest rivalry exists between the boats' crews, each endeavoring to get the greatest load for the day. Another boat is seen approaching, and away we go again, dodging this piece of ice, charging that piece with our sturdy bows, boring away where the ice lies closely packed, rounding this berg, and on to the next until we reach the boat, which is down to the gunwale in the water, with its crew cautious, plying their oars as they lie crouched upon their bloody load. So it goes on from day to day; hay is made while the sun shines, and the pile of skins and blubber rises high upon the ship's deck. Then comes a gale of wind, accompanied by fog, sleet, and snow, and we lay to under the lee of a stream of ice or a berg. The deck becomes busy with life, the blubber is "made off" and put into the tanks, and the skins are salted. When the gale is over, at the end of two or three days, the next few days of calm weather are again taken advantage of in the boats. Thus the periods of gales and calms which alternate in this part of the world come in quite conveniently for sealing, the produce obtained in the calm weather being "made off" during the gales. We never experienced much swell, being sheltered by the land, our work lying only a little east of Erebus and Terror Gulf. With "all hands and the cook" so incessantly occupied in the calm weather, all scientific observations were at a standstill, but in the evening, and sometimes during the night, a few chance readings could be obtained, and during gales fairly copious meteorological notes were obtained.

The seals are very foolish beasts. The present generation have never seen man, and they survey him open-mouthed and fearful, during which process they are laid low with club or bullet. Sometimes they are so lazy with sleep that a man may dig them in the ribs with the muzzle of his gun, and, wondering what is disturbing their slumbers, they raise their head, which quickly falls pierced with a bullet. There may only be one seal on a piece of ice, which is usually the case with the larger kind; but the smaller kinds lie in half-dozens and tens, and as many as forty-seven were seen on one piece. Seldom do any escape—one cartridge means one seal. Besides the three seals mentioned we came across a fourth, a large kind with a small head, small fore flippers, very thickly blubbered, and a more woolly skin. The last day of our sealing we were among a great host of the largest

big-headed seals, and as we were returning to our ship they were moaning loudly. This was said to be a sign that they were about to start upon a long journey, but was it not rather a sigh of relief when they saw their slaughterers' craft run up her bunting and announce to all that she was a full ship, that her thirst for blood was quenched? Penguins are the strangest creatures ever seen. They are supremely funny as they quack and strut about with their padded feet over the snow, or, coming to a slope, glide swiftly downward toboggan-fashion upon their breasts. If one lands on the piece of ice they are resting upon, they approach fearlessly with a threatening "Quack! quack!" For their inquisitiveness they, too, often received the handle of the club, for it was soon found that their flesh greatly resembled that of the hare, and upon them we had many a tasty and substantial meal. The emperor penguin is very difficult to kill; he will live after his skull has been most hopelessly smashed; the best way to put an end to them is to pith them. Six of us one day set out to capture one alive, and so strong was the bird that five with difficulty kept their hold, and, after he was bound with strong cords and nautical knots, he flapped his flippers and released himself.

The drift ice we came across was not heavier than that of Davis Strait, but the bergs were of very different character, nearly all flat, not pinnacled and not so lofty as those of the north, but of huge length, frequently being four miles in length, sometimes eight or ten, and one we met with was no less than thirty miles long, taking us six hours to steam from end to end at five knots. These are valuable when one can lie under their lee in a gale, but, when they are to leeward, form a dangerous lee shore, and more especially so for sailing ships.

One of the doctors had the good fortune to effect a landing in Erebus and Terror Gulf, obtaining specimens of plants, eggs, and rocks.

The lowest temperature recorded in the ice was +21·1° Fahr., or nearly 11° of frost; this was on the 17th of February, but usually it was about +32° Fahr., more or less.

On the 17th of February we steered for the Falklands, and thence homeward. Our homeward passage has been one continued spell of fine weather; the winds were mostly light, and too frequently head winds. The highest temperature recorded was 84·4° Fahr., in latitude 1° 10′ north, longitude 25° 21′ west, on the 13th of April; for the previous eight days 80° Fahr. and over are recorded, and also on the 3d of April, as well as five days following the 13th of April. From the ice to some degrees north of the line floats were thrown over to record the currents, and the townet was over frequently.

While in the ice we met the Jason, a Norwegian bark with

auxiliary steam power, under the command of Captain Larsen, and with her we kept company most of the time. He reached the ice about a month earlier than ourselves, and surveyed the pack edge as far as 30° west. Captain Larsen also landed on the South Orkneys and on Cockburn Island, where he obtained several geological specimens.—*London Times.*

HONEY AND HONEY PLANTS.

By Dr. G. G. GROFF.

THE popular idea is that all flowers alike produce honey, and that bees pass from blossom to blossom indiscriminately collecting the sweet fluid. This, however, like many other popular notions, is incorrect. By no means all flowers yield honey, and most of them yield it very scantily. Indeed, those plants visited by honeybees which yield any considerable amount above that consumed by the bees from day to day are, in any one section of the country, limited to a very small number, and usually not more than one, or at most two, of these plants are in blossom at one time. There are, however, a good many flowers that yield some honey, yet are for various reasons not visited by honeybees, among which we may name the honeysuckle (visited, however, sometimes for the pollen), and plants of the buttercup family. In some cases the honeybees can not reach the honey, in others it is probably not palatable to them.

It is also true that there is a great difference in the amount of honey produced in different years by the same species of plants. Sometimes there seems to be almost no honey at all in white clover, one of the best honey plants in our Northern States, while at other times honey is in the blossoms for a few days, and then it suddenly disappears, or in other seasons there is honey so long as blossoms of clover are to be found. The secretion of honey does not depend upon the season being moist, for usually the honey "flow" is greatest in dry seasons. There does seem to be some connection between the amount of honey produced and the character of the soil upon which the plants grow. Thus clover growing on clayey ground seems to yield more honey than that growing on hillsides where there is but little clay. The same is true of other plants. Often there is honey in one district and none in another not far distant.

The plants which yield "surplus" honey in the North Atlantic States in ordinary seasons are the red and black raspberries, the white clover, the basswood, and the buckwheat. Some other plants may yield small additional quantities, but are hardly of

practical importance. There are, however, some early spring flowers giving honey which is useful in stimulating brood-rearing in the hives, without which there is no hope of any surplus. We will first name some of these plants.

The practical bee-keeper knows that his hopes of obtaining honey all depend upon his having his hives full of bees when the "flow" comes. Brood is produced in quantity only when some honey can be obtained from flowers then in bloom. Hence the importance to the apiarist of the early blooming flowers.

The willows of several species, and the silver and red maples, blossom in March and April, depending upon the season. They yield both honey and pollen, and whenever the days are warm enough the bees constantly visit them. If one is about his apiary on warm days in March and April, he will notice the bees coming in with pollen even at times when no flowers have been observed. At such times they doubtless have found blossoms on some warm bank and are making good use of them. The poplar trees also bloom in April, a little later than the willows. Reference is here had to the true aspen poplars, not the tulip poplar. The dandelion and strawberry blossoms are much visited by bees. Later, about the first of May, we have the sugar maple and the blossoms of the fruit trees—the peach, cherry, plum, apple, pear, quince, etc. These all yield honey and pollen. During some warm and early springs, in very strong colonies, honey may possibly be stored which has been gathered from the fruit blossoms, but, as our seasons average, the honey from our fruit trees goes altogether to stimulate brood-rearing. The locust trees (both the honey and the black locust) blossom after the fruit trees and before the white clover. Surplus is seldom stored from these blossoms, though they are good honey producers. Their honey goes to produce more brood or to feed the colony until the clover comes. We next consider plants which produce surplus honey. These for the Atlantic States are few in number.

Of the plants which produce surplus honey the white clover is first named. This plant grows spontaneously throughout the whole region. In the well-cultivated sections it is almost the only honey-producing plant left on which the apiarist can any longer depend. It begins to blossom in June and continues on into July. The honey from this plant is the whitest and finest produced. It is entirely free from any peculiar or offensive taste or odor, and is a general favorite.

In the more northern States the red raspberry commences to blossom a little later than the white clover. This is a valuable honey plant of which bee-keepers in the South are deprived. This honey is considered by many to be fully equal to that of the white clover. In July the basswood blossoms. This tree yields

a great amount of honey, but unfortunately there are no longer many trees to furnish blossoms and nectar. This honey is darker than that from clover, and has also a peculiar odor, which is unpleasant to many persons.

The last plant of value as a honey producer is buckwheat, which begins to blossom in August and continues until frost. The honey from buckwheat is dark and has a taste of its own which is not offensive. This honey is very rich, and a taste for it is speedily acquired. The cultivation of this plant is becoming, year by year, more restricted, and is now confined to the newer and more mountainous sections.

Those regions where the land is all under cultivation have only the white clover to depend upon for honey, unless there are a few basswood trees along the streams, while in the mountainous areas will be found clover, basswood, raspberries, and buckwheat It takes but a moment, then, to decide where one could best hope to succeed in bee-keeping.

We place among the plants which produce a small or variable amount of honey the mint and figwort families; also the asters and golden rods. Of the first family, the mints, we have the horehound, the sage, bergamot, the catnip, and the motherwort, all producing considerable honey. Of this group, the most remarkable is the motherwort (*Leonurus cardiaca*), which is constantly visited by bees while it is in blossom. The supply of honey is limited only by the number of plants, which at present in most places is small. It has been suggested that this plant be cultivated for the honey it yields. It is now a rather unsightly weed. The figwort (*Scrophularia nodosa*) is an excellent honey plant. It has a square stem, and exteriorly a good deal resembles the mints. It is a worthless weed except for its honey-producing flowers. It is not very abundant. The wild mustard, the teasel, the boneset, the wild sunflowers, the Spanish needles, and the snapdragons, as also the smartweeds, produce some honey, though in most places the total is of little value. In Michigan, Prof. A. J. Cooke holds the golden-rods in high esteem as honey producers. In Pennsylvania the writer can not find that they are of any value at all. On newly cleared land the sumac springs up, and it is held by some to be a valuable source of honey, and that considerable amounts are some years collected from it.

The tulip poplar, popularly called "poplar," also produces honey in its beautiful large blossoms, but the tree is too scarce to be of much value to the bee-keeper. The blossoms of the blackberry, like their near relatives, the raspberries, are honey producers. The milkweeds are also secreters of honey. Curiously, the pollen of these plants often sticks to the heads of the bees and disables them so much that they perish. Prof. A. J. Cooke

says that at times the blossoms of the Indian corn yield both honey and pollen to the bees, but we think to no great extent. We have never observed the bees working on these blossoms.

The laurel (*Kalmia*) yields honey which is poisonous. Generally the bees do not work on these blossoms, but in some localities they do, and we frequently read of persons poisoned by honey which probably comes from this plant. It is thought that the poisoning of the Greek soldiers under Xenophon was by honey from this family of plants in this case from rhododendrons.

The plant lice (aphides) which infest many plants secrete a sweetish fluid of which bees, ants, and other insects are very fond. In seasons when real nectar is scarce or altogether lacking, bees will collect and store this material, which is generally known as honeydew or manna. There is, however, another variety of honeydew which seems to be secreted by the leaves of plants and is gathered by the bees. This material is hardly fit for human food, nor is it for bees either, and it is doubtless a principal cause of winter loss of colonies, for it produces in the bees a diarrhœa from which they perish if the winter is one of continuous cold, so that they can not take an occasional cleansing flight. Cider, juices of grapes, and all other sweet fluids are collected and stored by bees in seasons of scarcity. The general bad effects of all these are the same as of the honeydew—they produce intestinal disorders of which the bees die.

The profitable cultivation of plants, otherwise useless, for honey alone has never yet been demonstrated, and the low price of sugar will probably preclude any such efforts in the near future. Honey will remain a luxury, and as such will be produced in favorable locations—that is, on poor soil, where the honey plants grow naturally, and where the land can be utilized for nothing else. However, in the planting of shade trees it would be well to plant those which will produce honey as well as shade.

The effort is made by practical bee-keepers to find some plant, like the buckwheat, which may make a useful farm crop and at the same time produce honey. Many think alsike clover will do this. Prof. Cooke thus speaks of it: "Alsike or Swedish clover (*Trifolium hybridum*) seems to resemble both the red and the white clover. It is a stronger grower than the white, and has a whitish blossom tinged with pink. This forms excellent pasture and hay for cattle, sheep, etc., and may well be sown by the apiarist. It will often pay apiarists to furnish neighbor farmers with seed as an inducement to grow this *par excellent* honey plant. Like white clover, it blooms all through June into July. It should be sown early in spring with timothy, five or six pounds to the acre, in the same manner that clover is sown."

SKETCH OF PAOLO MANTEGAZZA.

By Prof. FREDERICK STARR.

AS a nation we know far too little of what is being accomplished in the world outside. We do in some degree keep track of the work of our English brothers, and occasionally some French or German worker compels our recognition. But there are many intelligent readers who do not know that Italy is to-day a veritable center of scientific work. Yet such is the case, and in such sciences as astronomy, zoölogy, and botany great progress is making there. Nor are they at all behind in anthropology; and the man who leads in Italian anthropology is Paolo Mantegazza.

No doubt to many American readers his Physiognomy and Expression, lately put into an English dress, is the only work of Mantegazza's known. It is a remarkable book—not only on account of its matter, which is of great value, but also on account of its style. There is scarcely a scientific book in any language that so plainly reflects its author, in his individual and ethnic characteristics. To read it is to gain a wonderful insight into the Italian mind and into the Italian mode of thought and expression.

Paolo Mantegazza was born at Monza, near Milan, Italy, on October 31, 1831. His mother was a remarkable woman—Laura Solera—well known for philanthropy and patriotism. No small part of the force of character, the strength of purpose, and the clearness which Mantegazza shows in his work seems to be inherited from this woman. She established the first *crèche* and founded the first professional school for women in Italy. During the wars of 1848 and 1859 she cared for the wounded soldiers. There appears to have been an unusual love between this mother and son, and Mantegazza refers to her at times in his writings. He always deferred much to her opinion; and in 1883, when some question had arisen as to the propriety of his famous book upon the Physiology of Love, the author submitted the book to her for judgment. Her letter of approval is presented in full in the introductory chapter of the work, and ends thus: "When I shall have the happiness of having you near me, I shall point out to you the passages which most please me. Meantime receive the enthusiastic greetings of your affectionate mama."

Mantegazza studied medicine in the Universities of Pisa and Pavia. Having become a physician, he spent several months in Paris and then journeyed over a large part of Europe. At the age of nineteen years he published a memoir upon Spontaneous Generation, and was appointed Acting Professor of Chemistry in the Technical School at Milan. The first of the remarkable series of anthropological works which has rendered his name famous—

The Physiology of Pleasure—appeared when he was only twenty-two years of age. It has been published and republished, translated and retranslated, and, although forty years have passed since its appearance, it is still issued in new editions in Italy. In 1854 Dr. Mantegazza removed to South America, and for four years practiced medicine at Buenos Ayres and Entrerios in the Argentine Republic and also in Paraguay. Returning to Italy in 1858, he practiced medicine and surgery in the military hospital during the war of 1859. In 1860 he secured, by competitive examination, the chair of General Pathology at the University of Pavia, and established in connection with that institution the first laboratory in experimental pathology, from which such eminent physiologists as Bizzazzero and Golgi have gone forth. In 1870 he removed to Florence to take the first chair of Anthropology. Here he has remained, constantly busying himself in every way that could extend the science to which he is so entirely devoted. Here he has founded the National Museum of Anthropology and Ethnology, the Italian Society of Anthropology, and the journal Archivio per l'Antropologia e la Etnologia. What Broca was to Paris and to France, Mantegazza is to Italy. The parallel is a strong one, for not only is Mantegazza, like Broca, a leader in anthropological science, but he is a leader of the most liberal portion of the workers in that field.

Of all sciences anthropology is the one which most keeps a man in touch with men and affairs. Every one knows the slap that the German emperor gave to Virchow recently at Berlin. The occasion was the birthday celebration of the two great scientists—Helmholtz the physicist, and Virchow the anthropologist. His Majesty congratulated Helmholtz upon having devoted himself so closely to his science that he had never meddled in political matters. It is easy for the physicist to do so. But how can a man who studies mankind hold himself aloof from human interests? Mantegazza has long been in public life. In 1845 he was sent from Monza as representative and was re-elected four times; while in 1876 he was elected senator of the kingdom of Italy. He has never been a political leader, but has always been clearly identified with the Liberal party.

Mantegazza's writings are exceedingly numerous and varied. He has written anthropological memoirs, works on medicine, volumes of travel, monographs upon special races, biographical studies, and romances. Among his more important anthropological works are Physiology of Pleasure, Physiology of Pain, Physiology of Love, Physiology of Hate, Love in Humanity, Hygiene of Love, and Physiognomy and Expression. All these have been translated into the leading languages of Europe and have exerted an immense influence. One or other of his books have

been translated into fourteen distinct tongues. His three works on Love—Physiology, Hygiene, and Ethnology—have sold by thousands in Germany and France. Perhaps the only one of his more important works which has appeared in America is his Fisionomia e Mimica—Physiognomy and Expression. This has been issued in at least two forms within the last three years and has sold largely. Although we have already referred to it briefly, it deserves especial mention. It is an excellent example of Mantegazza's nervous, impetuous style. Nothing that has been written elsewhere upon expression can approach it. Every great emotion of mankind is taken up, and the form of expression by which it makes itself known is exhaustively analyzed. The subject itself is so attractive and the treatment so interesting that the book—unlike most scientific books—will bear reading and re-reading for pleasure. No one but an Italian could have written it. Expression is at its best where the blood is hot and vigorous, and where people feel as they live; in such a country as Italy, and among a people like the Italians, only could such a study be so well made.

Analysis is the word which describes all of Mantegazza's work. Analysis shows itself in his writings; it shows itself also in his museum, one of the most remarkable in the world. It is the National Museum of Anthropology and Ethnology. Fair in ethnography, good in general anthropology, it is remarkable in somatology, and unique in psychology. Who but the writer of Fisionomia e Mimica could analyze so cleverly the material in Physical Anthropology? Who but so good an analyst could fail so utterly in combining the material into a symmetrical whole? Mantegazza's Museum of Psychological Anthropology is his latest hobby. Here he plans to show by material objects the operations of the mind—the development of religiosity, the expression of love, of fear, of cruelty—of every emotion of our kind.

As an editor Mantegazza has done vast service. His Archivio per l'Antropologia e la Etnologia is a standard journal in the science, but of course reaches only a select circle of fellow-workers. The Hygienic Almanacs, however, which have appeared under his direction for a quarter of a century, in editions of many thousands, have not only done much to improve sanitary conditions among his own people, but in their German and Hebrew translations have reached thousands outside of the land of his birth. While speaking of this service, we may mention that Mantegazza's contributions to medicine have been neither few nor unimportant. It was he who introduced coca into Europe, and his monograph upon this valuable plant was "crowned."

Mantegazza is to visit America in September, and it is to be hoped that he may meet that hearty kindness from us which he has always extended to American men of science in Italy.

EDITOR'S TABLE.

A GREAT WORK CONCLUDED.

ALTHOUGH there still lacks a volume of the ten originally planned by Mr. Herbert Spencer for the exposition of his Synthetic Philosophy, the publication of the tenth volume of the series (the second and concluding one of the Principles of Ethics) gives very legitimate occasion for rejoicing to all who, like ourselves, regarding the Synthetic Philosophy as the most important contribution yet made to an understanding of the laws of the organic world in their special bearing on human life, consider the portion dealing with ethics as the most important of the whole work. Mr. Spencer, we understand, having thus crowned the edifice of his philosophy, will proceed at once to complete it by writing the one volume still outstanding—namely, the third of the Principles of Sociology, or the eighth of the series.

It is, indeed, a long road on which the distinguished author looks back when his thoughts revert to the publication in the year 1855 of the first edition of his Principles of Psychology. For forty years very nearly has he been toiling over one of the most arduous tasks that any man ever set himself; and with what perseverance, unflagging resolution, and high spirit he has carried that task through its successive stages the world at large has been a witness. "You who write," says Horace, "consider well and long what your shoulders will bear and what they will not bear." It has seemed at different times as if Mr. Spencer had taken on his shoulders a burden too great for his physical strength. His health, as every one is aware, has for years together been such as greatly to limit his power of work, and at times to condemn him to complete inactivity. Still, he has persevered, making the most of all opportunities, and to-day his great undertaking is so nearly accomplished that its entire completion may be reasonably counted on. At one time this was more than the author himself hoped for, and more, we have little doubt, than any will less resolute than his own would have realized. We believe, and take pleasure in believing, that Mr. Spencer has been largely sustained in his severe and exhausting labors by the thought that he was working for his generation and for subsequent generations. His philosophy is meant for guidance. He has aimed at making men understand the kind of world they live in and the kind of laws with which they have to reckon. Theology has in general placed its most impressive sanctions in a supernatural order of things and in a future state of existence. Mr. Spencer contents himself with showing the springs, conditions, and consequences of human action in the present order of things, leaving those who are so disposed to find necessary admonition therein, and those who are otherwise minded to take their own course, whatever it may be. The question has often been raised whether philosophy can constrain men to right conduct. The answer we should be disposed to give is, that a true philosophy, one resting on the facts and laws of life, if duly blended with early education, would powerfully incline the young to virtue. It does not profess to be a stimulus for jaded appetites or exhausted moral vitality, and can not be counted upon as an agent for sudden conversions; but, given as the daily bread of life, it can nourish and strengthen the moral and intellectual natures of men.

"Give strong drink to him that is ready to perish;" but do not cast any reflections upon bread because, at such a moment, it might rather choke than aid the sufferer.

The volume which Mr. Spencer has just given to the world is one of great value and interest. In our book notices will be found a summary of its contents; but we desire here to add our commendation of it as an eminently practical treatise on the two important themes of Justice and Beneficence. The portion dealing with Justice was published separately two years ago, and was noticed in these columns at the time. Much of the matter which it contains is, however, of such urgent importance in the present day that we hope the publication of the complete volume will have the effect of calling attention anew to its analysis of rights and its trenchant discussion of the nature and functions of the state. The portions dealing with Beneficence under the two heads of Negative and Positive bring out in a striking manner the large element of sympathy in the writer's disposition. Careless critics have heretofore been in the habit of asserting that the evolution philosophy, as expounded by Mr. Spencer, enjoined pure selfishness. There was quite sufficient in earlier portions of Mr. Spencer's writings—particularly in the Data of Ethics, published in 1879—to disprove this assertion; but not even a careless critic could make it after reading, however cursorily, the volume before us. Here is a noble passage from the chapter on Succor to the Ill-used and the Endangered: "Doubtless it is well for humanity at large to maintain the tradition of heroism. One whose altruistic promptings are so strong that he loses his own life in an almost hopeless effort to save another's life, affords an example of nobility which in a measure redeems the innumerable cruelties, brutalities, and meannesses prevailing among men, and serves to keep alive hope of a higher humanity hereafter. The good done in occasionally putting egoism to the blush may be counted as a set-off against the loss of one whose altruistic nature should have been transmitted."

Mr. Spencer has himself anticipated the criticism that much of what he says in regard to beneficence will not seem to have any very clear connection with the doctrine of evolution; and so far he professes himself disappointed in the outcome of the work. We do not feel called upon to share in his disappointment. The doctrine of evolution has served in the earlier volumes to interpret the world for us, to enable us to understand our environment, and know both how it has come to be what it is, and how we have come to be what we are. That it should also serve as a guide through the complexities of human action is more than we ever expected. Knowing ourselves and our environment, the conduct we ought to pursue as being likely to result in the greatest amount of happiness to ourselves and others may be arrived at by reflection and experience. Mr. Spencer, in the last two sections of the present volume, analyzes the principal situations in which individuals are liable to find themselves, and shows in an instructive manner the conduct, negative and positive, appropriate to each. We do not see how much fault can be found with any of his conclusions. To us it appears that he lays down many of the most important principles of correct and useful social behavior, and that his treatise as a whole, but particularly the sections dealing with beneficence, would make the best kind of household reading for a large class of families. Philosophy here puts on a homely garb and walks hand in hand with the wisdom that every day's experience teaches. Until Philosophy does this, her work is not finished. Mr. Spencer's last words seem to us his best.

LITERARY NOTICES.

THE PRINCIPLES OF ETHICS. By HERBERT SPENCER. Vol. II. New York: D. Appleton & Co.

OF the three portions into which Mr. Spencer's new volume is divided, the first was published separately two years ago, under the title of Justice, and dealt with those things which human beings may claim as rights. The two latter portions now appear for the first time, and deal respectively with Negative Beneficence and Positive Beneficence. Mr. Spencer recognizes the sentiment of justice no less than the sentiment of beneficence as altruistic, the first implying a voluntary concession of the claims of others to free activity and the products or results of free activity, and the second a disposition to aid others in obtaining the objects of their legitimate desires. In the preface to the present volume the author acknowledges that the new parts fall short of his expectations. He has not been able to affiliate them to the extent that he hoped to the doctrine of evolution. "Most of the conclusions," he says, "drawn empirically, are such as right feelings enlightened by cultivated intelligence have already sufficed to establish." It is in ethics very much the same as in purely scientific theory. Specially gifted individuals will, by their deeper intuitions, anticipate the results of later experience or reasoning, and will thus succeed in formulating principles in advance of their definitive establishment. That the principal conclusions of ethics should not stand in very direct relation to the theory of evolution is not, however, surprising, inasmuch as these conclusions would in all probability be the same even if the history of human development had been materially different in its earlier stages from what it has been. What the evolutionist philosopher has to show, as it seems to us, is that there is no conflict between the principles of ethics and any of the deductions from the doctrine of evolution. If that doctrine were fundamentally unsound, the proof of its unsoundness might lie in the region of ethics, but the attentive reader of Mr. Spencer's last volume will at least be convinced that this is not so.

The warrant for beneficence as distinguished from justice lies in the fact that like justice it tends, if properly regulated, to promote life and happiness; but being in excess of justice, and therefore a more or less indefinite thing, the need for its proper regulation is very obvious. Mr. Spencer, as we have seen, deals with it under the two heads of Negative and Positive. A man is negatively beneficent if he abstains from actions which might promote his private interests, because he sees that such abstinence will promote the interests of another, his own being already sufficiently secured. Some of the examples which Mr. Spencer gives under this head may seem a little trite; but there are different ways of being familiar with a principle or rule of action, as John Stuart Mill once remarked. It is one thing to assent to a truth in a general way, and another to accept it with a full perception of all that it either presupposes or involves. Some of Mr. Spencer's counsels under the head of Negative Beneficence seem to resolve themselves into the familiar formula, "Live and let live"; but how many carry out that formula as fully as they should? It is an easy thing to repeat such a motto as "Live and let live"; but when it comes to foregoing a business advantage clearly within reach, in order that another individual may not unduly or undeservedly suffer, the motto is very apt to go to the wall, which, as every one knows, is a favorite place for mottoes. The question, therefore, is not whether the specific counsels given by Mr. Spencer have previously been given by others—Mr. Spencer admits that to a large extent they have been—but whether they are severally sound, and whether they are in harmony with his general system of philosophy. A motto or maxim floating in a kind of disengaged way in the moral atmosphere of the age does not carry at all the same authority as a rule of action forming part of a well-established system of thought; and the hope may therefore be indulged that an attentive reading of Mr. Spencer's new volume will lead many to see that maxims of conduct which heretofore they have felt themselves free to act upon or set aside according to the humor of the moment have a sanction which can not rightly be disregarded. Under the several heads of Restraints on Free Competition, Restraints on Free Contract, Restraints on Undeserved Payments, Restraints on Dis-

plays of Ability, Restraints on Blame, and Restraints on Praise, Mr. Spencer makes many excellent remarks bearing on every-day conduct. We regard these chapters, indeed, as moral discourses of the highest value, and commend them to the earnest attention of all whose duty it is to give moral instruction to old or young. Many a Christian minister might, we are convinced, infuse new life into his teaching by simply assimilating the contents of this volume and thus acquiring a fresh sense of the truth, the authority, and the interdependence of moral precepts which have heretofore had the warrant only of dogma or of sentiment.

To illustrate the class of matters with which Mr. Spencer here deals, we may quote the following from the chapter on Restraints on Displays of Ability:

"In nearly all cases the intrusion of personal feeling makes controversy of small value for its ostensible purpose—the establishment of truth. Desire for the *éclat* which victory brings often causes a mercilessness and a dishonesty which hinder the arrival at right conclusions. Negative beneficence here conduces to public benefit while it mitigates private injury. Usually the evidence may be marshaled, and a valid argument set forth, without discrediting an opponent in too conspicuous a manner. Small slips of statement and reasoning, which do not affect the general issue, may be generously passed over. A due negative beneficence will respect an antagonist's *amour propre;* save, perhaps, in cases where his dishonesty and his consequent endeavor to obscure the truth demand exposure. Lack of right feeling in this sphere has disastrous public effects. It needs but to glance around at the courses of political and of theological controversy to see how extreme are the perversions of men's beliefs caused by absence of that sympathetic interpretation which negative beneficence enjoins."

If any have heretofore supposed that the evolution philosophy leaves but a very restricted field, if any, for the exercise of practical benevolence, the volume before us should suffice to banish the idea. There is a wide scope, as Mr. Spencer shows, for negative beneficence, or self-restraint in the interest of weaker individuals, and there is also a wide scope for the exercise of positive beneficence or the active assistance to those less favorably circumstanced than ourselves. The one condition to be kept in view is that our assistance be not of a nature to cause subsequently more serious trouble or suffering than it alleviates in the present. The subdivisions of Positive Beneficence treated by Mr. Spencer are Marital Beneficence, Parental Beneficence, Filial Beneficence, Aiding the Sick and Injured, Succor to the Ill-used and the Endangered, Pecuniary Aid to Relatives and Friends, Relief of the Poor, Social Beneficence, and Political Beneficence. Here and there in reading these chapters, as also indeed in the section on Negative Beneficence, we find the line of demarcation between Beneficence and Justice a little shadowy. Both, of course, are subdivisions of Ethical Conduct in general, and that the two aspects, which Mr. Spencer for convenience of exposition tries to keep separate, should now and then seem to merge in a higher unity is not surprising. The man who has it in his power to be just or unjust, and who decides, against his own immediate interest, in favor of justice, must in general be moved by a sentiment of beneficence; and, on the other hand, the man who exercises a wise, rational, and restrained beneficence will probably regard his own conduct as, on a broad view of the matter, scarcely going beyond the limits of justice.

It might possibly puzzle some fairly informed readers to understand in advance what Mr. Spencer means by "political beneficence": the virtue is certainly one not much understood in political circles. Let the following sentence give the key to the puzzle: "Under a political *régime* like that into which we have grown, taking a share in political life is the duty of every citizen; and not to do so is at once short-sighted, ungrateful, and mean: short-sighted, because abstention, if general, must bring decay of any good institutions which exist; ungrateful, because to leave uncared for these good institutions which patriotic ancestors established is to ignore our indebtedness to them; mean, because to benefit by such institutions and devolve the maintenance and improvement of them entirely upon others implies a readiness to receive an advantage and give nothing in return." A passage which has special application to this country is the following: "In

America, where party organization is more developed than here, whoever declines to surrender his convictions and follow in the mob which is led by a 'boss' to the polls, is labeled with the contemptuous name of 'Mugwump,' and is condemned as pharisaic and of an unsocial disposition. In the 'land of liberty' it has become a political crime to act on your own judgment."

Mr. Spencer has not for a long time given us a book from which a greater number of striking and helpful quotations could be made than from this; but our notice has already exceeded the limits usual in these columns, and we close by renewing the expression of our hope that the admirably practical teachings which the book contains may be widely diffused and bring forth fruit abundantly.

DARWIN ET SES PRÉCURSEURS FRANÇAIS. ÉTUDE SUR LE TRANSFORMISME (Darwin and his French Precursors. A Study of Transformism). By A. DE QUATREFAGES. Paris: Félix Alcan. Pp. 294. Price, 6 francs.

THE purpose of this work, as defined by the author, is, looking at the subject from the point of view of natural science, to determine exactly what is Darwin's, find what is true in it as well as what can not be accepted of it, and to try and assign to each its value and the deductions which are drawn from it. Reduced to the terms of a descent of all animal and vegetable species by successive transformations from three or four original types and probably from a primitive archetype, it is found to offer little wholly new. Darwin himself has given a list of twenty-six naturalists of various nationalities who had published views more or less similar to his before him. Of these, M. Quatrefages has compared the expressions of the French naturalists, including Benoist de Maillet (or Telliamed), Robinet, Buffon, Lamarck, Étienne and Isidore Geoffroy-Saint-Hilaire, Bory de Saint-Vincent, and M. Charles Naudin. Suggestions of these ideas may be found further back still, even among the alchemists of the middle ages and the Greek sophists; but the question of the formation of species could not present itself to those thinkers with the same significance that it has done with us. Beginning with the seventeenth century, the proposed solutions multiplied rapidly. The author, not appreciating, perhaps, the patience which English philosophers have cultivated in the matter, thinks the process described by the term evolution too slow to account for the changes of species, and prefers transformism, with transformists as the appellation of the advocates of the theory. After the accounts of Darwin's French precursors, a general exposition of Darwinism and a review of its agreement with certain general facts are given; following which the Darwinian system is subjected to a full discussion in eight chapters. As every one knows, M. Quatrefages is not a Darwinian; but differences of opinion concerning heretofore unexplained phenomena, he says, never make him unjust toward eminent men. While he contests their doctrines he desires to render a sincere and cordial homage to their works. In Darwin he admires the almost chivalric good faith which enables him, even when his mind is most preoccupied with his hypotheses, to be still calm enough to see in his own labors reasons and facts that militate in favor of his adversaries and sincerity enough to point them out. "There is a real charm in following such a mind in its excursions." In the preface to a second edition of the work he dwells upon the neutrality of the Darwinian theory as concerns religious questions, and the impartiality with which it is sustained by orthodox and by agnostic supporters, or opposed alike by adversaries of either school.

EXTINCT MONSTERS. A Popular Account of some of the Larger Forms of Ancient Animal Life. By the Rev. H. N. HUTCHINSON. New York: D. Appleton & Co. Pp. 254.

THE object of this book is twofold: to describe some of the larger and more monstrous forms of the past, and endeavor by pen and pencil to present them as they were in life; and to illustrate how in animal life the past has grown into the present without the long and abrupt leaps which we are too liable to regard as one of the chief features of the transition. Stress is laid upon the quality of the illustrations. They are still to a certain extent conjectural, but they rest upon larger and more accurate information than any portraits of the giants and dragons of old that have previously appeared. Many

of the former pictures of these creatures were highly sensational; in some of the later ones neither art nor Nature had fair play, and we had to put up with awkward-looking creatures that could not get along at all in life, or with animals in attitudes which later researches have shown were not theirs. Hence our ideas upon these points need to be revised. The discoveries of later years have shown, as Dr. Henry Woodward observes in the preface he furnishes, "that the dicynodon and labyrinthodon, instead of being toadlike in form, were lacertilian or salamander-like reptiles, with elongated bodies and moderately long tails; that the iguanodon did not usually stand upon 'all fours,' but more frequently sat up like some huge kangaroo with short fore limbs." The discoveries of Marsh, Cope, Leidy, and others in America have added vastly to our knowledge of the real structure of these animals. We have now almost complete skeletons and details of the flying membranes of long and short tailed pterodactyles; the archæopteryx and Marsh's hesperornis and ichthyornis have given more definite shape to our knowledge of primitive birds; and the discovery by Prof. Fraas of the outlines of the skin and fins of ichthyosaurus have established the pertinency of the term fish-lizard as applied to it. These and other discoveries have been applied in the text and illustrations of this book; and we have, accordingly, the saurians of the sea and the land, the real dragons and sea-serpents of old, the monsters of America and of India—megatheriums, glyptodons, mastodon, mammoth, giant birds, Irish elk, and Steller's sea cow—represented with a clearer approach to accuracy than ever before, but still subject to correction by future discoveries.

BIBLE STUDIES. By HENRY WARD BEECHER. New York: Ford, Howards, & Hulbert. Pp. 438. Price, $1.50.

THIS is a volume of lectures on the early Old Testament books which were delivered in Plymouth Church on Sunday evenings in 1878–'79, as part of an unrealized design eventually to cover the whole Old Testament with the course. The lectures were taken down by Mr. T. J. Ellinwood, according to his custom of stenographically reporting all Mr. Beecher's public addresses, and are now published under the editorial supervision of Mr. John R. Howard. The whole force of them, Mr. Howard says, "goes to throw off all the cramping theory of 'inspiration' which makes God responsible for all the evil that was done by the inchoate Hebrew people in his name. Thus the student is left free to follow this master expositor in rediscovering and newly appreciating the wisdom, the goodness, the grand foundation-work of Moses under the divine impulse, which both served to build up the Israelitish nation and has entered into many of the soundest elements of modern civilization. . . . The attentive reader of these Bible studies will lose no living belief in the ancient Scriptures as containing the word of God to men, while he will gain new and larger views of their worth for Christian life to-day—and that not in spite of the new philosophy of growth, but in full harmony with its irresistible advance." Of special interest, as bearing upon the subject in its generality, are the first three lectures, on The Inspiration of the Bible, How to read the Bible, and The Book of Beginnings.

REPRESENTATIVE ENGLISH LITERATURE FROM CHAUCER TO TENNYSON. Selected and supplemented with Historical Connections and a Map. By HENRY S. PANCOAST. New York: Henry Holt & Co. Pp. 514. Price, $1.60.

THE author's attempt has been to write a book which should answer the needs of those who are beginning to teach the subject according to new methods. The tendency formerly was to study the history of literature without coming into real contact with the literature itself; now, in our anxiety to avoid this error, we are in danger of rushing into the opposite one, and of studying the literature torn from its living historic and human relations. In the present work the attempt is made to put the student in direct contact with some representative masterpieces, without ignoring the study of literature from its historical side. The sketches and selections are therefore presented in the order of their time by sequence, with a distinct historical thread running through the whole. The authors mentioned and quoted are presented in direct connection with the ages and surroundings in which they lived and wrote. The history and the surroundings are described

in four periods—the period of preparation, ending about A. D. 1400, of which Chaucer is the principal representative; the period of Italian influence (The Revival of Learning and the Puritan in Literature), 1400 to 1600, represented by Spenser, Bacon, Milton, the Elizabethans and the Puritans; the period of French influence, 1660 to about 1750, of which Dryden, Addison and the eighteenth century essays, and Pope are the most conspicuous examples: and the modern English period, including the earlier writers of this century and recent writers to Browning and Tennyson. In the appendix are a Literary Map of England, a list of authors to accompany the map, a Chaucer glossary, and an index.

THE NATURALIST ON THE RIVER AMAZONS. By HENRY WALTER BATES, with a Memoir of the Author by EDWARD CLODD. New York: D. Appleton & Co. Pp. 395.

WE have already, in our biographical sketch of Mr. Bates, borne testimony to the value of his work on the Amazons, and to the value and interest of this book, and now speak of the peculiar features of the present edition. It is a reprint of the original unabridged edition, with a map and illustrations, including a double colored plate of butterflies to illustrate the theory of mimicry. The description of the book in the subtitle as A Record of Adventures, Habits of Animals, Sketches of Brazilian and Indian Life, and Aspects of Nature under the Equator, during Eleven Years of Travel, shows how comprehensive and varied it is. The memoir, by Mr. Edward Clodd, a near personal friend, who had more than an editor's interest in composing the tribute, has been enriched by letters furnished by Sir Joseph Hooker and Mr. Francis Darwin, with letters from Sir Joseph Hooker and the elder Darwin to Mr. Bates.

A TREATISE ON PUBLIC HEALTH AND ITS APPLICATIONS IN DIFFERENT EUROPEAN COUNTRIES. By ALBERT PALMBERG. New York: Macmillan & Co. Pp. 539. Price, $5.

THE author is a health officer, and is active in movements in behalf of public health in Finland. The present edition of his work is a translation from the French original, made at his request by Dr. Arthur Newsholme, of Brighton, who has also brought up to date and completed the chapter on England, and summarized the recent legislation. The treatise is based on the practice in different countries. An analysis of the part relating to England will illustrate the plan and scope of the whole. The first chapter gives a general review of the sanitary administration, with accounts of the local government board, local sanitary districts, and local boards of health, duties of the several health officers, statistical tables, and the daily progress in an urban sanitary office. The next chapter comprises a summary of sanitary legislation as embodied in the Public Health Act of 1875—referring to drainage, utilization of sewage, privies and water-closets, sweeping and cleansing of streets, courts, and houses, water supply, common lodging houses, nuisances, offensive trades, etc., through many particulars provided for in the law named and in other sanitary laws. In a third chapter sanitary regulations are described with similar detail. The two following chapters are given to the sanitary conditions, administration, and regulations of London. The account is there extended to include other countries and their principal cities—Scotland and Edinburgh, Belgium and Brussels, Austria and Vienna, Sweden and Stockholm, and Finland and Helsingfors. These extracts are followed by statistics showing the importance of public hygiene. The book is rich in descriptions and illustrations of sanitary appliances modern and practical. The author has confined his accounts to countries whose methods he has seen and studied personally on the spot.

THE PHILOSOPHY OF INDIVIDUALITY. By ANTOINETTE BROWN BLACKWELL. New York: G. P. Putnam's Sons. Pp. 517. Price, $3.

THIS work or essay is characterized by the author as "a revised, a broadened, a more full attempt at verification of a system of thoughts less matured in the author's former works, Studies in General Science, and the Physical Basis of Immortality." Its position is that "the character of every perception and of every cognition, and of every mental act of all kinds is dependent in definite degrees upon each and all of the co-operating factors, psychical and physical, which together make up the entire process of every act in which the sensibility is consciously concerned. In other words, all change, all action (change and

action include both feeling and motion) is so entirely under the control of definite law that the sequence of every thought is fully determined by its correlatives of all kinds, in the sense that it must obey the associated laws of thought and of things. The mind must perceive objects, must know them, and must reason about them legitimately in true accord with its own mental attitude working in correspondence with the organism and the extra-organic world." We have found nothing in it clearer than this.

AN ELEMENTARY MANUAL ON APPLIED MECHANICS. By ANDREW JAMIESON. London: Charles Griffin & Co. 1892. Pp. 268. Price, $1.25.

THIS manual is intended especially for students beginning the subject, and forms a companion to the author's other elementary manuals on Steam and the Steam Engine and Magnetism and Electricity. The subject is treated under four general divisions, the first being devoted to statics or forces in equilibrium, the second to hydraulics and hydraulic machines, the third to the laws of motion, and the fourth to the properties and strength of materials.

The book consists of twenty-four lectures delivered by Prof. Jamieson, to his students and the method of treatment and the order of arrangement of the subject matter are based upon the author's experience in teaching. In conformity with this, he has placed the consideration of the laws of motion after that of hydraulics and hydraulic machines, as he finds that it is much better for the student to have some knowledge of simple mechanism before trying to understand the abstract laws of motion. Illustrative examples are given in each lecture, and a list of suitable questions at the end.

PRACTICAL ELECTRIC-LIGHT FITTING. By F. C. ALLSOP. London: Whittaker & Co.; New York: Macmillan & Co. Pp. 275. Price, $1.50.

THIS handbook should prove of interest and value not only to the practical electric-light fitter, to whom it is primarily addressed, but to the householder using the electric light who desires to take an intelligent interest in the subject as well. The author begins his exposition with a brief but clear statement of the meaning and relation of current, electromotive force, and resistance, which is quite free from technicalities and understandable by any one without previous knowledge of the subject, and then passes to a consideration of the various appliances and details of construction essential to a complete electric-light outfit. Among the subjects considered are systems of central-station supply, switches, cutouts, incandescent and arc lamps and their accessories, electroliers, running of wires, arrangement of circuits in a house, sizes of wires for a given number of lamps, and meters. All these subjects are treated briefly but clearly, so that the ordinary householder can readily understand them. A full statement is given of the rules of the London underwriters, and the work closes with a chapter upon private installations.

MAGNETISM AND ELECTRICITY. By ARTHUR WILLIAM POYSER, M. A. London and New York: Longmans, Green & Co. 1892. Pp. 382. Price, $1.50.

THIS very excellent manual is designed for advanced students, and the subject is treated so as to give the student an experimental knowledge, the text being intended to be an aid to the experimental study and not a substitute for it, as is so often the case.

The main experimental facts of the science of magnetism and electricity are set forth by the author, and simple experiments suggested which the student can perform without the use of elaborate apparatus. A chapter is devoted at the close of the book to some of the applications of the principles of the science, in which the telephone, microphone, electric lamps, and the dynamo are briefly described, and a short but instructive account is given of the recent researches of Hertz in proof of the electro-magnetic theory of light of Clerk Maxwell, and those of Tesla with currents of great frequency.

HEREDITARY GENIUS. By FRANCIS GALTON. London and New York: Macmillan & Co. 1892. Pp. 379. Price, $2.50.

IN republishing this inquiry into the question whether natural ability is hereditary, Dr Galton has chosen to leave it in much the same form in which it first appeared more than twenty years ago, as to recast it and incorporate data now accessible would have involved greater labor than he could well

undertake. The inquiry was originally undertaken at a time when it was believed that the individual mind was capable of almost indefinite development, if only it was properly trained and had coupled with it the necessary will power to urge it on. The outcome of the researches was, however, to show that the mental faculties of the individual are as rigorously limited by ancestral conditions as are those of the body. In support of his conclusions Dr. Galton has examined the kinship of a number of men who have attained eminence in various fields of labor, and has shown that the number of relatives who have been above the average are greatly in excess of the number of such relatives that would exist if there were no causal relation. The classes of eminent men passed in review comprise the English judges, statesmen, great commanders, literary men, men of science, poets, musicians, painters, divines, senior classics of Cambridge, oarsmen, and wrestlers. While the range of Dr. Galton's inquiries is necessarily limited, his main position seems to be established and all our later knowledge is in the direction of its support. The important bearing of this research is upon the future of the race, and Dr. Galton therefore discusses the relation of fertility to ability, and sees reason to believe that in the course of evolution the race may attain a level as high above the highest now existing as this is above the lowest at the present time.

ELECTRICAL PAPERS. By OLIVER HEAVISIDE. Two volumes. London and New York: Macmillan & Co., 1892. Pp. 560, 587. Price, 30*s*.

THESE volumes contain the contributions of the author during the past ten years to the mathematical development of electrical theory. The papers have been contributed to various scientific periodicals without any intention originally of making them the basis of a systematic treatise, but aside from a few miscellaneous ones at the beginning of the first volume they are of sufficient continuity to present the subject in an orderly, logical development. The papers cover the mathematical treatment of the relations between magnetic force and electric current, the energy of the electric current, induction of currents in cores, electro-magnetic induction and its propagation, and electro-magnetic waves. The views of electrical action and the propagation of electric disturbances here worked out are those first propounded by Clerk Maxwell, and which have in the last decade come to be widely accepted by scientific men, and are forming the basis of all further research. Mr. Heaviside's discussions are addressed only to the mathematical physicist, and are quite beyond the lay reader. They have been recognized as of a high order of merit by scientific men, and have taken their place as a valuable contribution to the scientific literature of the subject.

ALTERNATING CURRENTS. By FREDERICK BEDELL, Ph. D., and ALBERT CUSHING CREHORE, Ph. D. New York: W. J. Johnston Co.; London: Whittaker & Co. 1893. Pp. 325. Price,

IN this work Drs. Bedell and Crehore, of Cornell University, have undertaken to develop the theory of the alternating current in a more complete and logical form than has hitherto been done. The work is mathematical, and appeals only to the scientific student of physics. The authors divide their treatment into two main divisions, in the first of which the problems of an alternating circuit are treated analytically, and in the second graphically. In each mode of treatment the simpler cases of circuits containing resistance and self-induction only, and resistance and capacity only, are first taken up, and then the more complex cases of circuits containing resistance, self-induction and capacity, and resistance and distributed capacity are considered. The solutions obtained are of universal application, though for the sake of clearness the authors give numerous examples of the application of the general formulas. Parts of the work have appeared as separate papers in various scientific periodicals, and have met with very favorable reception from scientific men.

AN ATLAS OF ASTRONOMY. By Sir ROBERT STAWELL BALL. A Series of Seventy-two Plates, with Introduction and Index. New York: D. Appleton & Co. Price, $4.

HAVING received an invitation to prepare a new astronomical atlas, Prof. Ball undertook the work with the view of supplying an elementary series of maps, such as had been asked for by the readers of his Starland.

The scheme gradually developed, however, so that while suitably supplying the wants of beginners in astronomical study, the atlas has taken on a scope which makes it more widely serviceable. The plates comprise a general star map in twenty sections, a series of twelve monthly star maps, and several other important single maps and groups. The moon is represented in charts of the four quadrants, and there are also telescopic views of the moon of each day's age from the third to the fourteenth. Each of these pictures is furnished with a key and index of names, and it is believed that students of our satellite will find these plates of much service in identifying the various lunar objects. Other plates represent phases and orbits of the planets, solar phenomena, comets, nebulæ, systems of satellites, eclipses, etc. An introduction of fifty-seven pages describes the plates and gives a list of select telescopic objects suitable for observation with small instruments. Another feature of the present work is an index to planets. The identification of these bodies is difficult for a beginner, on account of their shifting positions. The author has removed this difficulty for the next decade by providing a simple method of learning in a few seconds the approximate position of every important planet. It should be noted that the mechanical execution of the volume is of a high grade.

LIFE AND LABOR OF THE PEOPLE IN LONDON. Edited by CHARLES BOOTH. Vol. III. Blocks of Buildings, Schools, and Immigration. Vol. IV. The Trades of East London. London and New York: Macmillan & Co. Price, $1.50 each.

THESE volumes consist of correlated essays on various features of its subject by a number of special writers. They form a uniformly straightforward account, abundantly fortified by statistics, of how the poorer classes of London work and live, and how their children are educated. There is no sentiment and few comments or suggestions in these volumes; they are crowded so full of facts that no room is left for such matter. Compact tables of figures are introduced frequently, and in Volume III colored maps show the proportions of native and foreign-born population in London and in England. The information which the work contains is of the highest value to the sociologist and deeply interesting to any one who wishes to know "how the other half lives" in a great city. The essays are far from dry, in spite of their meatiness. Thus, one of those devoted to model buildings is a sketch of life in buildings, which is notably graphic. In the chapter on the Jewish Community is a vivid account of the progress of a "greener" from the time he enters the Thames on board an immigrant steamer until he is established in a little business, perhaps two or three years later. The accounts of elementary education and of the secondary education of boys and of girls are also very readable. The trades that receive attention in Volume IV are tailoring, bootmaking, dock labor, furniture-making, tobacco-working, silk manufacture, and women's work; there is also a special chapter on Sweating by the editor. A thorough insight is given into the conditions of work in these trades, and some idea of how both male workers and factory girls spend their leisure is also afforded. These volumes are an excellent example of what sort of investigation is necessary as a basis for any intelligent efforts toward bettering the condition of the poor in a large city.

The *Handbook of Emergencies and Common Ailments* of *E. F. Bradford*, M. D., assisted by *Louis Lewis*, M. D. (B. B. Russell, publisher, Boston), is a really valuable work, larger and fuller than most of the books of similar title, but less bulky and diffuse, and therefore more valuable and practical than ordinary books of household medicine. The author's purpose in preparing it was to present to non-professional readers directions for the diagnosis and treatment of the class of cases described in the title. The author's plan has been to treat the subjects more fully and extensively than is done in the numerous handbooks already in circulation, and to describe in sufficient detail the latest remedies and methods of treatment, or such as are available and easily understood. The object has been kept in view, too, besides pointing out specific remedies for different ailments, to discuss and explain some of the general principles upon which a sensible practice of medicine is founded. The book is divided into five parts. Part I presents some general introductory remarks on symp-

toms and the signs of disease and of death, and on the use of medicines; Part II relates to injuries and wounds and their treatment; Part III, to sudden attacks, painful attacks, pain in the chest, and pain in the stomach; Part IV, to some common ailments and diseases of the skin; and Part V, to diseases of infancy and childhood; numerous particular forms of attack being described under each heading.

A *Manual of Physics* for university students, prepared by Prof. *William Peddie*, of Edinburgh, has been issued by G. P. Putnam's Sons (price, $2.50). It is a treatise of a high grade, and is confined to pure science. It makes large use of mathematics, but the author states that the student may assume the results of the mathematical portions, and use the remainder, which is much the larger part, of the text in his study of experimental physics. The volume has an index, and there are over two hundred diagrams in the text.

The ejection of blood from the eyes of the lizards of the genus *Phrynosoma*—popularly called horned toads—is now attracting considerable attention. In the *Proceedings of the United States National Museum*, *O. P. Hay* gives a very interesting account of his experiments with this lizard. It appears that upon irritating the animal blood spurts from just above the eye. For what purpose the horned toad thus besprinkles an enemy with his own blood, what is the source of the blood, and how is it expelled with such force, are the questions that are puzzling biologists. It is suggested that the purpose of the ejection is to defend the animal from the attacks of enemies, although it seems improbable that the discharge would seriously pain or affect an enemy; however, Mr. Hay thinks it likely that this is the purpose of the habit, and he says: "A discharge of blood into the eyes of some pursuing bird or snake might so seriously interfere with its clearness of vision that the lizard might make its escape while its enemy was wiping its eyes."

The determination of the source of the blood has offered serious difficulties to the investigations of biologists, the most probable theory being that the blood or matter is lodged in a blood sinus upon each side of the head, a portion of the wall lying on the inner surface of the eyelid. This sinus is supposed to be surrounded with muscular tissue of sufficient force to cause the thin wall in the lid to be ruptured and the blood to be ejected to a considerable distance. These toads are found in nearly all parts of California, and are called by the Mexicans "sacred toads," "because they wept tears of blood."

In the *Contemporary Review* Prof. *A. H. Sayce* contributes a valuable paper to philological literature, which he entitles The Primitive Home of the Aryans. Until recent years the accepted belief was that the parent speech had its home in Asia, probably on the slopes of the Hindu Koosh. The parent speech of the Indo-European languages was entitled the *Ursprache*, or "primeval language"; but, as linguistic history developed, this supposition was abandoned, for it was found to differ from Sanskrit or Greek only in its fuller inflectional character. Sanskrit then became the parent, and its home was determined to be in Asia, the choice being fixed upon two arguments, the first of which is linguistic, the second being historical. "On one hand it has been laid down by eminent philologists that the less one of the derived languages has deflected from the parent speech the more likely it is to be geographically nearer to its earliest home"; . . . and, "as Sanskrit was held to be the most primitive of the Indo-European languages to reflect clearly the features of the parent speech, the conclusion was drawn that that parent speech had been spoken at no great distance from the country where the hymns of Rig-Veda were first composed." Prof. Sayce, however, draws attention to the fact that the result of recent discoveries has been a complete revolution in the study of Indo-European etymology; and that whereas, ten years ago, Sanskrit was invoked to explain Greek, "it is to the Greek that the new school now turns to explain Sanskrit." He claims, with Dr. Penka, that "southern Scandinavia was the primitive 'Aryan home,'" and he adds that "a more profound examination of Teutonic and Keltic mythology, a more exact knowledge of the words in the several Indo-European languages which are not of Indo-European origin, and the progress of archæological discovery will furnish the verification we need" to establish that in Europe and not Asia was the home of the parent speech.

The Birth of Invention is a most interesting pamphlet, by *Otis T. Mason*, Ph. D., Cu-

rator of the Department of Ethnology, United States National Museum. He brings his reader to "the day when the first being worthy to be called a man" stood upon the earth, and he describes his utter poverty of clothing, tools, experience, language, etc. "All Nature laughed at him." But "the one endowment that this creature possessed, having in it the promise and potency of all future achievements, was the creative spark called *invention*." From this beginning Mr. Mason evolves an interesting narrative of the progress of invention, using "five guides upon his interesting journey." The first is history, the second philology, the third folk lore, the fourth is archæology, and the fifth ethnology. And, as a result of the assistance of these mediums, he claims that we now have on earth types of every sort of culture it has ever known.

The second part of the pamphlet is devoted to a treatise on American inventions and discoveries in medicine, surgery, and practical sanitation, by John S. Billings, M. D., Curator of the United States Medical Museum. Dr. Billings draws attention to the enormous number of applicants for license to prepare and sell patent and secret medicines, and, while denying the benefits derivable from such nostrums, he claims that their existence is solely due to advertising; that he knows of only four valuable secret remedies, and that proprietary and secret remedies are largely responsible for the establishment and support of some of our newspapers and journals. To give an idea of how far the patent-medicine craze has gone, he tells of a "patent automatic doctor," on the principle of "put a quarter in the slot and take out the pill that suits your case." In 1880 there were in the United States five hundred and ninety-two establishments devoted to the manufacture of drugs and chemicals, the capital invested being $28,598,458, while there were five hundred and ninety-three establishments devoted to the manufacture of patent medicines and compounds, the capital invested being $10,620,880.

As a pleasure resort and a reminiscence, the White Mountains never tire. As a field for scientific exploration they are likewise perennial. That their powers of literary suggestiveness have not yet been fully drawn upon is proved by a collection of out-of-door sketches of Mr. *Frank Bolles*, entitled *At the North of Bearcamp Water* (Houghton, Mifflin & Co., $1.25). Bearcamp Water is a little river that flows from Sandwich into the Ossipee Lakes. "At the north" of it are the Chocorua Lakes and the mountains Chocorua and Passaconaway and their less imposing companions—Mr. Bolles's home, where he lives when he is not drudging at Harvard University, nearly equally related to the base of Chocorua—famous as the most characteristic and picturesque peak in New England, and the lakes. His "strolling chronicles," as he calls them, give vivid photographs of this most interesting region, the lakes, rivers, valleys, and mountains, and the life there in summer and winter. Mr. Bolles roams around them at will; regardless of season or weather, pushes boldly into the obscure recesses of the untrodden wilderness; spends an August night in a thunder-shower alone on the narrow ledge of Chocorua's precipitous peak; essays climbing the mountain through the snow; carves his own way up Paugus; and accomplishes as a matter of course that which the amateur mountaineer of two weeks a year shrinks from as a kind of modified suicide. He knows the birds, the bears, and the squirrels, and has an Orphean way of calling the birds around him in flocks at will; and he tells of all these things with the air of one who is occupied with them for the love of them; and in telling of them has added another to the most valuable and attractive of our outdoor Nature books.

An excellent *United States Relief Map*, published by the Geological Survey, is of convenient size and shows clearly and distinctly the elevations of all the parts of the country—including coast lands, valleys, plateaus, and mountains regions, at convenient intervals. The elevations are designated by a series of nine distinct shades of color, from white to dark brown, showing depressions below sea level and elevations from sea level to 100 feet; from 100 to 500, 500 to 1,000, 1,000 to 2,000, 2,000 to 5,000, 5,000 to 8,000, 8,000 to 11,000, and above 11,000 feet.

Who? When? and What? (*Parmalee & Chaffee*, publishers, New York) is a chart of the famous men and events of the six centuries, 1250 to 1850. It shows the centuries

in vertical columns; and in horizontal red lines within the columns the lives of the persons whose names the lines respectively bear, with arrowheads pointing out the years of their birth and death. The chart is otherwise arranged in three grand divisions, viz., literature, thought, discovery, invention, etc.; second, fine arts; and, third, music; while prominent movements and events marking the progress in each division are duly and plainly noticed. Attached to the chart is an index, by the aid of which each name recorded may be easily found.

A series of seventy-two *Normal Temperature Charts, by Decades, for the United States and the Dominion of Canada*, compiled by Mr. A. J. Henry, and published by the Signal Department under General Greely, comprises reductions of observations from about sixty stations, selected so as to represent the entire area of the country. These charts, it is observed, have become a necessary aid in the work of the Forest Division, and have been published in the expectation that they will also become valuable adjuncts in the duties of local observers, with reference to forecasting the weather and furnishing information; as well as to observers charged with the preparation of weekly or monthly crop bulletins.

Prof. *Adolphe Dreyspring's* method of teaching the French and German languages is conformed to the maxim *Repetitio mater studiorum*, or the rule of constant repetition. He uses only a limited vocabulary and enlarges it slowly; and exercises the pupil in all possible changes in the use and order of these words, and in a great variety of adaptations. Then he tries to make his lessons interesting and amusing by casting them in the form of a story, and illustrating them with pictures which, while pleasing to the eye, suggest the translation. The *French Reader, on the Cumulative Method*, is intended to follow the Easy Lessons in French, as a first attempt at more extended reading. In it the pupil will find a vocabulary familiar from the Easy Lessons, to which much has been added that is new. The book recites the story of Rodolph and Coco the chimpanzee, which has been composed with considerable knowledge of what children like, and is adapted to instruct them and amuse them at once. (American Book Company.)

A Report on the Higginsville Sheet, Lafayette County, is the first of a series of similar reports which are to be issued by the Geological Survey of Missouri, *Arthur Winslow*, State Geologist, containing the results of detailed examination in the respective areas. The localities selected for such work are those which are of prominent economic importance or of great geological and scientific interest. The form of publication is novel, and is intended to bring forward the map and section sheet as the prominent features, subordinating the report to them. Hence, the form of the modern small map sheet is adopted, with a scale of an inch to the mile, each map representing a quarter of a degree on each side, or one sixteenth of a square degree. The map is geological and topographical, and is accompanied with a section sheet containing cross-sections of profiles and underground structure and numbered columnar sections showing details of geological formations.

Truth in Fiction, by *Paul Carus* (Open Court Publishing Company, Chicago), includes Twelve Tales with a Moral, or rather allegories, for only the first one, The Chief's Daughter, is a real story, and in that the allegorical significance is as prominent as are the incidents. The lesson taught by it is that while we may throw away ordinances and ceremonies, we need not forget the principles and the truths which they cover, and which they are intended to symbolize or suggest. In the second story, After the Distribution of the Type, the doctrine is suggested that, while the man passes away, his work, that which he taught and gave to mankind, lives on eternally; and in that is the real immortality. In like manner the particular forms of doctrine and philosophy which Mr. Carus upholds are presented, and agnostic principles are defended, or those features which he regards as absurd are satirized, in the other stories.

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POPULAR MISCELLANY.

The Scientific Meetings at Madison, Wis.—The coming meeting of the American Association for the Advancement of Science will be held in Madison, Wis., August 16th to 23d inclusive. Previous to the former date, the American Microscopical Society will meet August 14th, 15th, and 16th, under the presidency of the Hon. Jacob D. Cox; the Geological Society of America, August 15th and 16th, Sir J. William Dawson, president; and on the same days the Association for the Promotion of Agricultural Science, Prof. J. P. Roberts, president; the Association of Economic Entomologists, Dr. S. A. Forbes, president; and the Association of State Weather Service, Major H. H. C. Dunwoody, president; and after the adjournment, the International Botanical Congress. The meetings of the Botanical and Entomological Clubs will be sandwiched between those of the association. Free excursions will be

given on the Saturday to Devil's Lake, about forty miles from Madison, and the Dells of the Wisconsin River, about eighty miles distant; besides three excursions of sections. The International Botanical Congress will consider questions of botanical interest, but papers embodying the results of research will be excluded, and the International Standing Committee upon Nomenclature is expected to make its report. Mr. William Harkness will be president of this meeting of the American Association; and the sectional vice-presidents will be: (A) Mathematics and Astronomy, C. L. Doolittle; (B) Physics, E. L. Nichols; (C) Chemistry, Edward Hart; (D) Mechanical Science and Engineering, S. W. Robinson; (E) Geology and Geography, Charles D. Walcott; (F) Zoölogy, Henry F. Osborn; (G) Botany, Charles E. Bessey; (H) Anthropology, J. Owen Dorsey; (I) Economic Science and Statistics, William H. Brewer.

Large Game.—Among the animals described in Mr. Rowland Ward's Measurements and Weights of the Great Game of the World, precedence is given to the hippopotamus of Africa. Not unlike him is the manatee, now extinct in the West Indies, but surviving in the upper Amazon. Both kinds of marine cattle, observes the Saturday Review, graze upon water weeds at the bottoms of the streams; but the manatee is harmless under all circumstances, while the hippopotamus sometimes plays the part of an assailant. A very formidable enemy he can be, for his massive tusks—all tusks are measured at the root—are sometimes more than nine inches in circumference. Still more dangerous are the razor-like tushes of the boar, and they are none the less dangerous that they are short. The greatest length of the outside curve is given at ten inches, and yet the boar has been known to come off victorious in a battle with the Bengal tiger. In contrast with one another stand the muntjac, a deer of India and the warm countries of the southern Pacific, with a "sweep" of horns of only six inches and a half, and the sambur, which weighs six hundred pounds and has a "magnificent" spread of antlers of two feet and a half from tip to tip. The best of the American wapiti is more than half as large again as the Scottish red deer, and the grand Carpathian species yields in size to the extinct Irish elk. Generally speaking, we find that the weight of deer depends partly on the climate, but chiefly on the food. The caribou, or reindeer, is an exception. The farther north you find him, the better he seems to thrive, and, like the musk ox, he fattens on the arctic lichens; and the moose, which haunts more southerly forests and swamps, is decidedly smaller. There are some remarkably graceful dwarfs of the deer tribe. Kirk's antelope of East Africa wears Lilliputian horns three inches long; and Salt's antelope from Somali Land is still more minute. The beautiful little gazelles of Oriental poetry seem to do well anywhere; apparently they can dispense with water and lay on flesh in a wilderness of sand and stones. Naturally, they are always in high condition, and it is no easy business to ride them down. A very remarkable group are the wild sheep and goats which have been attracting so many adventurous rifles to the Rocky Mountains and Sierra Nevada, to the Himalayas and the plateaus of Kashmir and Thibet. The horns of the finest Himalayan ibex which was killed by Mr. Kennard had a span of four feet and a quarter. Those of a wild goat from southeastern Europe, which fell to Colonel Marston's rifle, were a trifle longer. These, again, are surpassed by the curve of the best markhor, a denizen of the higher Himalayas, resembling the goat. When you cross the Indus into Afghanistan, the curved horns of the markhor are curiously straightened and fall away in length by a fourth. The length of the longest tiger skin after drying is said to be thirteen feet six inches; but it must be noted that skins expand considerably in the curing. The greatest length of a skin undressed is given as ten feet two inches and a half.

The Company of the Dead.—In Mr. Charles Hose's journeys in North Borneo, he found one morning after his night's rest that the remains of his host's last wife also occupied the room, where they were kept in a large box serving as a coffin. It is the custom of these people to keep a corpse in the house for three months before burying it. The body is then removed from the house and conveyed with much ceremony to the tomb. Every one present sends one or more cigar-

ettes made of tobacco, wrapped in the dry leaves of the wild banana, to his dead relatives in "Apo Leggan" (hades). These cigarettes are placed on the top of and around the coffin; and, should the body be that of a man, his weapons, tools, and a small quantity of rice, with his *priok* (cooking pot), are deposited in the tomb with him that he may be able to continue his daily pursuits in the other world. But if of a woman, her large sun-hat, her little hoe—used for weeding in the paddy fields—her beads, earrings, and other finery are placed with her body, that she may not be found wanting on her arrival the other side of the grave. Mr. Hose was once present when the corpse of a boy was being placed in the coffin, and he watched the proceedings from a short distance. As the lid of the coffin was being closed an old man came out on the veranda of the house with a large gong and solemnly beat it for several seconds. The chief, who was sitting near, informed him that this was always done before closing the lid, that the relations of the deceased who had already passed out of this world might know that the spirit was coming to join them. There was another strange ceremony at which he was once present, called "Dayong Janoi," in which the dead are supposed to send messages to the living, and which proved that "spiritualism" was of very ancient practice among the Kayans.

Heat Phenomena of the Diamond.—In his experiments with the diamond Mr. Moissan has found that, in his thermo-electric apparatus for burning in oxygen, when the temperature was slowly raised the combustion proceeded gradually without the production of light; but if the temperature was raised 40° or 50° C. above the point at which this slow combustion begins, a sudden incandescence occurs, and the diamond becomes surrounded by a brilliant flame. Various deeply colored specimens of diamonds burned with production of incandescence and flame at temperatures of from 690° to 720° C., but transparent Brazilian diamonds did not attain the stage of slow combustion without incandescence till the temperature of from 760° to 770° C. was reached. A Cape diamond suffered gradual combustion at from 780° to 790° C. Specimens of exceedingly hard boort began to combine with oxygen at 790°, and burned brilliantly at from 840° to 875° C. When Cape diamonds were heated with hydrogen to a temperature of 1,200° C., they remained unchanged; but if the stones had previously been cut, they frequently lost their brilliance and transparency. Dry chlorine gas was found incapable of reacting with the diamond until a temperature of from 1,100° to 1,200° C. was attained. Hydrofluoric-acid vapor likewise only reacted at about the same high temperature. Vapor of sulphur also requires to be heated to 1,000° C. before reacting, but in the case of black diamonds bisulphide of carbon is produced at about 900° C. Metallic iron, at its melting point, combines with the diamond in the most energetic manner; and it is a point of considerable interest that crystals of graphite are deposited as the fused mass cools; hence the experiment forms a striking method of converting the allotropic form of carbon that crystallizes in the cubic system into that which crystallizes in the hexagonal system. Melted platinum likewise combines with the diamond with great energy.

Hurry, and the Chance of Life.—In a paper on The Duration of Life of the Nervous American, Dr. Julius Pohlman asks, "Is this so often quoted 'fearful nervousness' and 'early death' a fact or merely an assertion? What proofs have we for it? It seems very plausible, indeed, and apparently correct physiological reasoning to say that the individual's longevity is in inverse proportion to his daily hurry, all other things being equal. But not many years ago the equally misleading but equally plausible statement was accepted that the human race was growing smaller with the advance of civilization. "First of all," the author continues, "the assumption that increased activity and greater hurry mean more rapid wearing away of the body ignores the fact that the human body is a wonderful piece of machinery, which not only renews itself constantly, but whose strength and power of endurance and capacity for more work increase with increased use up to the point at which use becomes abuse. At what time and under what pressure this danger line is reached depends upon the individual." The testimony of the executive officers of four of our largest life-

insurance companies is quoted to show that "from the material standpoint of dollars and cents the life of the American is at least as good as, if not better than, that of the European, all other conditions being the same. And if we remember that probably the majority of the holders of policies of life insurances in this country is made up from those same active, pushing, and rushing men, a class among which death from overwork would naturally occur most frequently, then the figures mentioned acquire additional force. A compilation drawn from every available source regarding the estimated duration of life at different years of age in America and in Europe gives figures that show that the chances of the American, from early manhood to a good old age, are, all through, a little better than those of his English brother, and a good deal better than those of the Germans.

Funeral Customs of the Haida Indians (Queen Charlotte Islands).—According to the Rev. C. Harrison, all men, and particularly the chiefs among these Indians, are greatly honored on their departure from this world. When the man dies, the next to succeed him (generally his nephew) is presented with blankets, dishes, beads, guns, canoes, prints, pottery, dogs, axes, and furniture. They are not, however, for his own benefit, but for the benefit of the deceased, and those who take part in the burial ceremony. In fact, nothing seems to be too valuable for the funeral. Christians are afraid to break the news of a friend's death to his wife, father, and mother. Not so, however, with the Haidas. The author has seen them make the coffin and decorate it in the presence of the sick person when they have come to the conclusion that he is about to die. They also tell the sick man that he will not recover, and urge him not to attempt to do so. The members of his tribe and all the chiefs of the other tribes come in to see him, and talk of nothing else but of others who have had the same sickness and died. When he hears what they have determined that he should do, he then refuses to eat and drink, and so hastens the demise. When gasping for breath, he is washed, and his shroud, made of white cotton, is then put on; white stockings are put on his feet; he is clad in a pair of white woolen drawers, and a white handkerchief is tied around his head. His neck is encircled with beads, a spot of red paint is put on either cheek, and a black spot on his forehead. When thus arrayed, all his friends enter the house and wait until he dies. They think very little of each other when in health and strength, but as soon as they are dead they become valuable and are called good Indians. When a person dies, they arrange a bed in the corner of the house and cover it with white cotton and place the deceased thereon, and then they cover him with a sheet of the same material. In twenty-four hours' time the body is placed in the coffin and arranged in the position in which it is to be buried. Then the time of mourning comes. All the old women of the tribe and the friends and relatives of the deceased begin to groan and sigh and cry. After they have wept for one or two hours, the greatest chief present calls for silence. Then the smoking feast begins. During the smoking entertainment the chiefs and friends of the deceased, according to rank, will begin to extol his virtues, and try to console his relatives by reference to his disposition toward the poor, his love for his friends, and his kindness toward his wife and children; and they also are very careful to refer to his liberality when making a free distribution of his goods—namely, a *potlatch*. Everything done in his past life passes under review, and they then conclude by saying that his time had come, and that the gods wanted him, and he, being a good and wise man, had obeyed their summons. When any one of importance dies, the news is carried to all the villages, and they at once come to see the dead man and also consult with the relatives regarding the funeral arrangements. If the deceased person belonged to the Bears, the funeral preparations are made and conducted by the Eagle Crest, and *vice versa*. After the funeral is over, all the people are feasted by the deceased man's nephew, who then assumes his uncle's title and property.

Self-purification.—The results of recent discussions in Europe, in which Prausnitz, Prof. Pettenkofer, Prof. Buchner, and Prof. Frankland have taken part, indicate that "self-purification" of rivers by oxygenation and sunlight, while it may be sufficient

for water applied to ordinary uses, can not be relied upon for the perfect sanitation of water intended for drinking. This conclusion is confirmed by the recent experience of some towns in Massachusetts. Continued outbreaks of typhoid fever in Lowell and Lawrence were ascribed by the State Board of Health in 1890–'91 to the admission of typhoid-fever excreta into the river from towns higher up the stream, where it was known to have existed. Newburyport has for the past ten years, or since the introduction of a public water supply, been comparatively exempt from typhoid fever; but recently, in consequence of a scarcity of water, the water company began pumping a part of its supply from the river and distributing it to the inhabitants in the face of expert warning against doing so. In January, 1893, the cases of typhoid fever, following closely after a similar prevalence in Lowell, suddenly rose from an average of less than one a month to thirty-four in January, with five deaths.

East African Superstitions.—Mrs. French-Sheldon, who traveled in Africa from Teita to Kilimegalia and secured a propinquity to the natives under natural conditions rarely enjoyed by white travelers, became acquainted with some very curious superstitions among them. The people of Taveta have an idea that the preservation of the skull preserves the spirit of the dead, and that the congregation of the skulls of a family or tribe guarantees a future reunion. They avoid letting any stranger know of the death of one of their tribe. If a familiar face is missed, and an inquiry is made, some one promptly says, "He has gone on a journey." They have a horror of having their pictures or photographs taken. They wear certain beads and bits of wood or iron as charms to ward off evil, and as *dama* for various complaints. They are loath to part with these beads, beans, or bones. They will lend them to one another when suffering, but always reclaim them when their friend has been cured. The fires in the village were never allowed to go out; a special family fire might go out, but this could be resupplied or reignited by getting a blazing fagot from some friend's fire. But in the history of the tribe they had always preserved the fire, as doubtless did their prehistoric ancestors. When the Wasombo learned that Mrs. French-Sheldon intended to descend to Devil's Water, as Lake Chala was called by them, they speedily retreated to their villages, with a feeling of horror that the white woman would dare to venture into the very mouth of the devil. She therefore made her visit free from annoyance. It is believed that the Masai had a village where the crater lake now swells and gurgles, and that during a volcanic eruption of Kilimanjaro the people and their herds and poultry were blown into mid-air, and that their spirits still hang in space, without home above or below, and that the moaning and soughing of the wind through the trees and the strange rustling and mysterious noises caused by the reverberation of the rocky cliffs surrounding the lake proceed from the spirits of these poor people, their cattle and poultry. Although fish are abundant in this lake, the natives could not be induced to taste them. The same people believe that their ancestors inhabit the bodies of the Colobus monkeys, and will not under any circumstances knowingly kill or permit to be killed one of those animals; and on approaching the forest where the monkeys abide in great numbers, they preserve an odd silence, with furtive glances, and pick their steps with a precaution and almost hesitation that indicate an honest belief in their superstition.

Prehistoric Jeweled Teeth.—Among the interesting objects brought from Copan last year by Messrs. Saville and Owens, of the Peabody Museum of American Archæology and Ethnology, are several incisor teeth, each of which contains a small piece of green stone, presumably jadeite, set in a cavity drilled on the front surface of the teeth. The museum had before received from Yucatan human teeth filled in a peculiar manner, and now it has teeth from Copan filled in the same way. This is of particular interest in adding one more to the several facts pointing to Asiatic arts and customs as the origin of those of the early peoples of Central America. A most striking resemblance to Asiatic art is noticed in several of the heads carved in stone; one in particular, if seen in any collection and not labeled as to its origin, would probably pass almost un-

challenged as from southern Asia. These may prove to be simply coincidences of expression of peoples of corresponding mental development brought about by corresponding natural surroundings and conditions.

Photographing Savages.—A lively use of the camera is recommended by Mr. E. F. Im Thurn as a means of getting representations of savages in their real life. The usual illustrations in works of anthropology and travel, when they are not merely physiological pictures, are pronounced by him almost universally bad. "Of old, the book illustrator, if, as was usual, he was not himself the traveler, drew as pictures of primitive folk merely the men and women that surrounded him, figures of men and women of his own stage of civilization, and merely added to these such salient features as he was able, from the traveler's tales, to fancy that his supposed primitive subject had. . . . The modern anthropological illustrator does indeed generally draw from photographs, but almost always from photographs taken under non-natural conditions." They are either taken in town, where the savage is away from his usual haunts and in unaccustomed surroundings; or the mere thought that he is being photographed puts him under constraint. "That to gain the confidence of uncivilized folk whom you wish to photograph is one of quite the most essential matters you will easily understand. The first time I tried to photograph a red man was among the mangrove trees at the mouth of the Barima River. My red-skinned subject was poised high up on a mangrove root. He sat quite still while focused and drew the shutter. Then, as I took off the cap, with a moan he fell backward off his perch on to the soft sand below him. Nor could he by any means be persuaded to prepare himself once more to face the unknown terrors of the camera. A very common thing to happen, and to foil the efforts of the photographer at the very moment when he has but to withdraw and to replace the cap, is for the timid subject suddenly to put up his hand to conceal his face, a proceeding most annoying to the photographer, but interesting to the anthropologist, as illustrating the very widespread dread of primitive folk of having their features put on paper, and thus being submitted spiritually to the power of any possessing the picture. . . . A curious instance may be mentioned of the discovery, thanks to the camera, of that rather rare thing—a personal idiosyncrasy among red men. Some time last year in photographing a number of Carib lads I noticed that one of them at the moment of the taking of the picture suddenly put up his hands and put them, not over his face, but one on each shoulder. The attitude struck me at once as an unusual one, but yet it seemed to me in some way familiar. Some time after, in looking through my old stock of negatives, I found one which showed a much younger Carib lad in the same unusual attitude, and it was only after some inquiry that I realized that this last-named negative was one which I had taken some years before of the same boy." There is a field here for the use of some of the "snap" instruments.

The Reasons of Conventionalities.—Conventionalities are treated by the London Spectator as things which must grow up with the growth of civilization, yet which, while they are not to be despised, are no more to be exalted into absolute and universal obligations. Even on matters affecting merely the external order and harmony of life, there are conventions which, though not intended to repress and exclude all overflow of individual genius, are still of great value in controlling the arbitrary eccentricities of individual nature, and in reducing men's manners and modes of expression to terms which one might speak of as commensurable with the manners and modes of expression of those who live with them in the same moral atmosphere. The mere beauty of any social life depends on the conformity of all—within variable but definite limits—to conventions, which, though by no means of supreme obligation, yet render the give-and-take of life much more natural and gentle and easy than if each man or woman were to blurt out the feeling uppermost in the individual mind, without any of that toning-down and softening which exclude abrupt and noisy explosions of individual self-will. Not all social conventions are beautiful. Sometimes the artificiality of them exceeds whatever is either necessary or advantageous for the pur-

pose of mutual understanding and mutual forbearance; yet some of them are in their essence beautiful, because they are founded on the principle of charity as well as truth. They control jealousy and rivalry; they repress vulgar competition; they express disinterested sympathy. In fact, they transform a selfish mob into an orderly society. Still, though without these etiquettes and courtesies of civilization social life could hardly exist, yet it would be impossible to speak of any of the conventions which render it possible as if they were laws of intrinsic and moral obligation to which there are no exceptions. They are but principles which govern the average or ordinary usages of men, but none the less principles which give way, and rightly give way, before any urgent individual need, or even any moderate pressure of clear utility.

Chinese Newspapers.—The Chinese Government instituted an official journal at a very early date, the Pekin Gazette having existed since B. C. 740. It was at first printed upon engraved wooden blocks, but now movable characters cut in wood are used. There are three editions of the paper, of which only the official edition is printed in this manner. The second edition is printed with waxen plates on which the characters are cut, and, the work being done in haste, is not very legible. The third edition is in manuscript. The official edition is printed on one side of ten or twelve very thin doubled leaves, is eighteen centimetres high and ten broad, and is divided by lines of violet ink into seven columns, each containing fourteen ordinary characters. It appears every morning. The manuscript edition is a little smaller than the official edition, and appears several days before it. Its price is many times higher, and it is largely used by foreigners. The journal furnishes a real panorama of the official and social life of the Chinese. The reading of it is very entertaining; for we may find in it, among other documents, the day which the emperor has decided upon for changing from the winter hut to the summer hut; that six of the candidates for the license were more than ninety, and thirteen more than eighty years old, illustrating the fact that one is never too old to be examined in China. This Pekin Gazette was the only journal published in China till about twenty years ago. Since then some five journals have arisen at Shanghai, Tien-Tsin, at Canton, at the instance of the English, with the co-operation of Chinese literati. The Chen Pai, of Shanghai, which was started in 1885, is an illustrated weekly journal, with eight doubled leaves and a red cover, the engravings in which are done in Chinese style in outline. In one of the numbers of this journal the last conflict between the French and the Chinese is represented, with the French commander Fournier in the costume of an English admiral. All the journals together publish not more than fifteen thousand copies. The attempts made in them to transcribe European words phonetically are sometimes amusing, thus *ultimatum* becomes "ou-ti-ma-toung"; *statu quo*, "sseu-ta-tou-ko"; telephone, "to-li-foung," etc.

The Fire of Incandescent Lamps.—An active incandescent lamp may be broken in the midst of cool combustibles, even of gun-cotton, without setting them on fire, so rapid is the destruction of the carbon filaments in the open air. But a long continuance of the lamp in immediate contact with a combustible envelope may determine ignition, the more readily the more slowly heat and air pass through the envelope. Thus gummed cotton or other goods will take fire more rapidly than similar goods ungummed or loose. Some interesting experiments in this property have been made by an Austrian engineer, Captain Exler. Having determined the temperature produced by certain measured lamps in paraffin in which they were plunged, he washed them with pulverin, ecrasite, and powdered gun-cotton; no change took place in their condition. In thicker coatings ecrasite fused, and the powder slowly lost its sulphur, but neither took fire. The effects were more marked when the substance was spread upon a surface capable of wholly arresting calorific radiation. It is therefore prudent to guard against bringing naked lamps too close to a combustible surface. When the lamp was surrounded with an envelope, the temperature between the two surfaces rose. In fifty minutes it became sufficient to decompose fulmicotton and carbonize wood. Black

powder lost all its sulphur, but did not take fire. With a lamp inclosed in a bell glass the three explosive substances were decomposed in twenty minutes. Water, with which the interval was filled, came to the boiling point in fifteen minutes. It was observed even when the beginning of an ignition of the explosives was determined, the flame was not sure to be propagated, unless the substance had been previously warmed. On the other hand, a derivation of weak resistance, produced between the two conductors of a lamp, determines a strong flame, capable of igniting all combustible substances. A lamp may be broken by a shock, by overheating, or by some unknown cause. If only a crack is formed, the air getting within causes the filament of incandescent carbon to burn up in a very short time. If the lamp bursts or has a hole made in it, the danger is greater, and may cause the ignition of explosive gases, but not of fulmicotton or dry powder. It is not safe, therefore, to conclude that an accident is absolutely impossible.

The Whirlpools of Charybdis and Scylla.—Charybdis and Scylla, the whirlpools of which much was fabled in classical antiquity, are situated in the strait of Messina, between Sicily and Italian Apulia. Although they were a great terror to ancient navigators, they are in reality rather small affairs, and it is difficult to determine their exact positions. The whirlpool of Scylla is situated at the foot of the cliffs on which is the little city of that name, which are hollowed out into caverns. The circulation of the waves in these grottoes produces, in times of heavy seas, a sound like the barking of a dog. Charybdis is near the port of Messina, nine marine miles from Scylla. Although it was reported unfathomable, it is, according to Spallanzani's measurements, not more than five hundred feet deep, and is therefore far from being the deepest spot in the Mediterranean. It is difficult to comprehend why the ancients should have had such a terror of sailing between these two eddies so far apart, but the task of explaining the riddle has been undertaken by the engineer, M. Keller. Observations made by him at Messina show that the currents of the strait depend, first, on the tide, and, secondly, on the wind. The currents are very strong, because the tide is low in the Ionian Sea when it is high in the Tyrrhenian Sea, and *vice versa*. Hence, also, the formation of whirlpools at different points in the strait. These whirlpools are energetic in proportion to the strength of the current, and when at their strongest may offer a serious danger to navigation. At the syzygies, with the wind from the southeast, the waters tumble from the Ionian Sea into the strait and form whirlpools north of the port of Messina; they are likewise formed near Faro, where ships at anchor are sometimes carried out to sea and borne by the current upon the rocks of Calabria, toward the point of Pezzo, a little farther away than Scylla. We may therefore suppose that the ancients meant by Charybdis these casual whirlpools near the port of Messina, and by Scylla those of Point Pezzo. Between these two points the currents are extremely rapid and strong and variable besides. Under such circumstances an inexperienced sailor might therefore have difficulty in passing the strait of Messina without falling from Charybdis into Scylla. The danger is really serious for sailing vessels, which were the best the ancients knew of.

Consumption at Davos Platz.—A case is recorded by Dr. A. T. T. Wise, of Davos Platz, Switzerland, of a consumptive manifesting serious symptoms ordered to that place for the mountain air, who began to regain lost ground in two weeks after his arrival, near the end of October, 1891. Progression toward recovery, with gradual expansion of the chest and gain in weight, was uninterrupted till February, 1892, when the physician's examination showed improvement near to recovery in every affected part. In October, 1892, the patient, having gained twenty-eight pounds in Davos, had resumed his practice of medicine, was in robust health, and presented no sign of disease except a faint, hardly perceptible expiratory harshness over the left apex. The climatic advantages at high altitudes in pulmonary disease, as summarized by Dr. Wise, are: Dryness of the air and its comparative freedom from micro-organisms and atmospheric dust, entailing a lessened liability to catarrh and irritation of the bronchial tract and drying the lungs; profusion of sunlight; with the

low temperature, the heat of the sun is easily borne, and the violet rays of the spectrum act chemically on the blood, increasing the hæmoglobin; diminished barometric pressure, which facilitates chemical action in the blood and tissues, favors vaporization of moist secretions in the lungs, and aids pulmonary circulation and expansion; and the general stimulus of high levels, producing exhilaration and an increase of nutrition.

Facts about the Growth of Boys and Girls.—A summary of the results of an investigation of the laws governing the growth of various parts of the body, instituted in the schools of Worcester, Mass., in 1891, is published in Science. Some three thousand two hundred and fifty individuals were examined, of ages ranging from five to twenty-one years, and comparisons were made in the growth of boys and girls. The length of the head in girls is shown to be less than that of boys throughout the whole period of growth, and consequently through life; but the difference in length, instead of remaining the same from year to year, varies considerably, and the annual increment is irregular in both sexes. In girls the greatest length of head is reached about the eighteenth year; in boys, not before the age of twenty-one. The girls' heads are narrower than those of the boys, while the phenomena of breadth of head, in periods of alternate growth and cessation of growth, are similar to those of length of head. The faces of the girls are broadest at seventeen, those of the boys after the eighteenth year; while the faces of the boys are usually broader than those of the girls. In stature, the boys, starting out at five years of age, are apparently taller than the girls, but the girls appear to catch them in the seventh year, and continue at an even stature up to and including the ninth year, after which the boys again rise above the girls for two years. About the twelfth year the girls suddenly become taller than the boys, and continue taller until the fifteenth year, when the boys again and finally regain their superiority in stature. After the age of seventeen there seems to be very little if any increase in the stature of girls, while the boys are still growing vigorously at eighteen, and probably continue to grow for several years after that age. The curves of the sitting height present the same characteristics, somewhat more accentuated, as the curves of stature. The curves of weight, while presenting the general characteristics of the curves of stature and sitting height, show minor differences. The superiority of the girls in respect to weight is for a much shorter period than in respect to total height or sitting height. In weight also the girls seem to reach their maximum average at seventeen, while the boys continue to increase in average weight until a much later period in life. The movements of the curves of the index of sitting height indicate that the greater part of the growth in stature up to the twelfth year in girls and to the fifteenth year in boys is made in the lower limbs, while after these respective ages it is made in the trunk. The results of the whole series of measurements afford evidence, deemed conclusive, that women reach maturity before men, and that, for all the measurements except the weight, girls have completed their growth by their eighteenth year.

Paradoxes of the Witch-hazel. — The witch-hazel, according to a correspondent of Garden and Forest, is a true witch among shrubs. It has a wild way of growth, several crooked, branching trunks growing from the root; smooth leaves; four very long, linear petals, yellow and twisted or curled. So far it is not unlike other shrubs. The name "hamamelis" indicates its most striking peculiarity, "flowers and fruit together on the tree." It blossoms in October and November, and the flowers of this fall will be the fruit of next fall, which hangs on the bare boughs when it next blossoms. The flowers, though small, are made noticeable by blossoming in clusters on the stem. The fruit is a woody capsule, nut-like, two-celled, and the seeds, almost black and shining, are the prettiest seeds in the world. Another peculiarity of this curious shrub is its explosive seed-scattering. "Many years ago, wishing to secure a quantity of these seeds to make a necklace like one I had seen, it became a question how to get them. Before the nut was ripe enough to open, it was almost impossible to get at the seeds, and when the capsule opened they were shot out suddenly, scattered far and near, and lost. A quantity of the almost ripe seed-pods were

gathered, put in paper bags, and hung up to wait and see, or rather to wait and hear, what would happen. For days these pods, as they dried, kept popping in the bags, and the seeds, small and polished, very like rice in shape, were secured. . . . But when the seeds were gathered there was another problem to be solved—how to thread them. The finest, sharpest needle would split them every time. The friend who had threaded them told me how it could be done. The seed was to be cut off at each end with a very fine file. This was a labor of love, and the necklace was pretty enough to pay for the trouble."

Crystallization of Metallic Oxides.—M. Moissan has succeeded, with the high temperature obtained in a newly devised electrical furnace, in fusing and crystallizing many of the metallic oxides. At temperatures ranging from 2,000° to 3,000° C., magnesia, lime, and strontia crystallize and then quickly melt; boric acid, protoxide of titanium, and alumina are volatilized; and the oxides of the iron family, stable at high temperatures, furnish melted masses bristling with little crystals. These important results were only the prelude to still more remarkable experiments intended to lead up to the preparation of carbon under high pressure, and the artificial production of the diamond. Having studied the solubility of carbon in a certain number of metals in fusion—such as aluminum, iron, manganese, chromium, uranium, silver, and platinum—and in a metalloid, silicon, he succeeded in obtaining by fusion in one of these metals new varieties of graphite; but he was able to produce crystallized carbon, or diamond, only by performing his experiments under high pressure. When iron in fusion is saturated with carbon, different results are obtained according to the temperature to which the mass is raised. Between 1,100° and 1,200° C., a mixture of amorphous carbon and graphite is obtained, and at 3,000° C. graphite exclusively in beautiful crystals. If a high pressure is introduced, the conditions of crystallization are completely changed. The process employed by the author resulted in the production of three kinds of carbon—graphite in small quantity when the cooling was quickly done, a carbon of a chestnut color in very thin flakes, and a small quantity of a dense carbon which was isolated by treatment with the strongest acids. The very minute fragments scratched rubies and burned in oxygen at 1,000° C. They seem, therefore, to be incontestably diamond. Some of the fragments are black and others transparent. M. Moissan's reporter speaks of his having, in the production of these diamonds, surprised one of the secrets of Nature—ignoring the diamonds obtained several years ago, under a similar high pressure, from hydrocarbons by Mr. Hannay, of Edinburgh.

East African Finery.—Among the presents which Mrs. French-Sheldon received from the Masai when passing through the East African country called Kilimegalia, were the characteristic articles, a vulture-feather pannier, vulture-feather shoulder capes, dancing masks of various kinds, shields, swords, and a collarette made of cropped ostrich feathers stuck through leather, so that the quills make a rough surface on the inner side. "This is worn only by the warrior who has killed twelve persons, and resembles in theory the robe of Janus, as the roughness on the inner side produced by the quills excoriates the surface of the neck of the wearer. The warrior who gave me this collar had the blood streaming from his throat to his waist. One warrior presented me with a wooden case filled with ostrich feathers, which he carried with him to replace the feathers in his warrior mask and for other decorations. I bought several of the cow skins worn by the women as clothing and for bedding at night, for the cold is extreme. They presented me also with a dancing wand, and one of their *nebana*, or cloths made of strips of white cotton and embellished with red, of various designs, which they sling from their shoulders; also a colobus monkey tail, which they wear under their knees, over the long oval bells, and a hyena tail decorated with a lion mane and colobus monkey tails, which they suspend from their shoulders as an emblem of war."

The Masais of East Africa.—The Masais of East Africa, according to Mrs. French-Sheldon, are true warriors and raiders. They keep a subject tribe, the Wa-sombutta, who do their hunting and what meager agriculture they indulge in. The people of this tribe are insignificant in appearance, and, al-

though servile and subject to the Masai, are not slaves. They present almost the appearance of dwarfs. "I saw no man among them," she says, "who attained a height of over four feet and a few inches; most of them were very much smaller. The Masai know no law but that of capture, and attack the Taveta with much animosity. Their custom of forbidding passage through their territory is enforced by placing in the middle of the path, over which an individual or a caravan must pass, a bullet over which they cross two twigs stripped of foliage, with the exception of a tufted top; the first person crossing this barrier is usually speared or shot. Not knowing of this custom, I inadvertently came to such a barrier and kicked it aside, when I was seized by one of my headmen, who held me back, informing me that if I crossed that point I should most likely be assassinated; and in a moment about thirty young Masai warriors made their appearance in a great state of agitation, with frantic gesticulations, announcing that I must pay a certain amount of *hongo* for the depredation I had committed." The author had great difficulty in getting even instantaneous photographs of any of the tribes. They regarded the camera as a species of witchcraft, and were put to flight the moment they saw a square box held up before them. But they were greatly entertained by the music-box; and the principal men of the tribe would sit by the hour round the tent while it was playing, waving themselves backward and forward, and repeating "God! god! god! give us rain! god, give us clothes!" until Mrs. French-Sheldon began to feel that her resources in the way of exerting influence with the supreme power were very much overtaxed.

Platinum and its Sources.—Platinum is used in the manufacture of incandescent electric lamps, in the construction of stills for the concentration of sulphuric acid, as material for the wires by which artificial teeth are fastened to plates, and in smaller quantities for chemists' crucibles, jewelry, etc. For all these purposes about 215,000 ounces are consumed every year. The Ural region of Russia has for many years supplied all the platinum used in the world. Other mines of far less productiveness are in the United States of Colombia, British Columbia, and the United States. Colombia produces about a hundred and twenty-five kilogrammes of the metal, all from native washings. The platiniferous area, although of low grade, is very extensive, and in part suitable for hydraulic mining. A considerable quantity of American capital, it is said, has been invested there, and Colombia is expected to become an important producer of the metal. The only platinum deposits of importance in British Columbia are on the Talameen River. The total production of this province is about sixty-five kilogrammes. Much prospecting for platinum has been done in the United States, but so far without success in finding paying quantities, and to the present time all the platinum produced has been incidental to the production of gold from various auriferous gravels in California and Oregon.

NOTES.

According to a paper by Miss Millicent W. Shinn, the great refractor of the Lick Observatory and the observatory itself may be traced to Mr. Lick's desire to be immortalized by leaving bequests for costly statues of himself and family. He was told by Mr. Staples that "more likely we shall get into a war with Russia or somebody, and they will come round here with war ships and smash the statues in pieces in bombarding the city." Mr. Lick was so struck by this that he asked, "What shall I do with the money, then?" when the suggestion of the telescope was made.

Many of the allusions and much of the science found in sixteenth century literature, including the works of Jonson, Spenser, Marlowe, Massinger, and Shakespeare, are derived from the *De Proprietatibus Rerum* of Bartholomew Anglicanus, a Franciscan monk, which was written in Latin about the middle of the thirteenth century, and was translated into English by John of Trevisa in 1397. The work affords a curious insight into the ideas of our ancestors about natural phenomena, and into their credulity in believing the stories of wonders from far countries. Much of it is derived from ancient authorities. A budget of selections from this book has recently been published in London.

The oscillation of projectiles is photographically recorded by Prof. Neesen, of Berlin. He employed hollow projectiles, in the interior of which was placed a sensitive plate, illuminated by sunlight through a small opening. During the rotatory flight of the projectile the ray of light described curves

on the plate, from the position of which, taken in conjunction with that of the sun, the oscillations of the axis and point of the projectile could be calculated. The results obtained showed that both perform oscillatory movements during flight very different from those usually believed to take place.

Two Akka girls, representing the dwarf race of Africa on exhibition in the European cities and supposed to be between seventeen and twenty years old, are described as being well proportioned, and as tall as a boy eight years of age. Their behavior is infantile, wild, and shy, but without timidity. They are very different in disposition; the more pleasant one laughs joyously, is pleased with bead bracelets and other trinkets given to her, and curiously expressed her appreciation of some chocolate bonbons. They show no wonder or admiration at persons and things, and are not affected by artistic furnishings, and their eyes are without expression.

A CORRESPONDENT of Nature tells of some letters and papers on his desk which were set on fire by a paper weight composed of four glass balls. It concentrated the rays of the sun upon them. The desk was scorched, and the burning papers, falling upon the carpet, burned that.

Two instances of what may be called "dust photographs" are described in Nature by W. B. Croft, of Winchester College. The plate-glass window of a hotel in London has on the inside a screen of ground glass, near but not touching, on which are the words "Coffee Room" in clear, unfrosted letters. One day, as Dr. Earle, the writer's informant, was at breakfast, the screen was taken away, but the words were left plainly visible on the window, and no washing would remove them. In another case the house had been a hotel, and the windows had been dressed with brown gauze blinds, bearing the words "Coffee Room" in gilt letters. A succeeding tenant on misty days saw these words on one of the windows.

THE results of six months' observations of Mars have led Mr. Schaeberle, of the Lick Observatory, to the conclusion—contrary to the generally received view—that the dark portions of the disk represent land, and the light portions water. This is supported by observations of San Francisco Bay from Mount Hamilton, in which the bay appears brighter than the neighboring valley and mountains at the same distance. On this hypothesis the "canals" would correspond to ridges of mountains almost wholly immersed in water, while their doubling may represent parallel ridges of which our own earth furnishes examples.

THE dangers of poisoning in the manufacture of white lead are avoided in a process introduced by Mr. J. B. Hannay, by which a sulphate of lead is produced instead of a carbonate. The pigment is made direct from the cheapest lead ore, which is crushed and fed into coke furnaces. The heat combined with an air-blast causes the lead to volatilize; the fumes are exposed to a current of steam, and the resultant creamy-white liquid mass is run off into settling tanks, whence it is passed into filter presses, deprived of its moisture, and dried and packed for market.

SOME oysters experimented upon by Prof. R. C. Schiedt, under exposure, living, to light with the right valve of the shell removed, in the course of a fortnight developed pigment over the whole of the epidermis of the exposed right mantle and on the upper exposed sides of the gills, so that they became dark-brown all over that side. They also made a partly successful effort to restore the right valve. The inference is drawn from the facts that the development of pigment in the mantle and gills was wholly and directly due to the abnormal and general stimulus of light over their exposed surface, and that the mantle border, the only pigmented portion of the animal, is pigmented because it is the only portion which is normally and constantly subjected to the stimulus of light.

ATTENTION has been called by Sir Henry Mance to the damage inflicted on electric telegraph cables by the teredo, which are described as being really serious, and the suggestion made by Mr. Preece several years ago is approved by the author, that, besides surveying the bottom of the sea for rocks and shoals, the parts near the shore should be examined to find whether they are infested by this pest.

IN a paper published in Science, on Variability of Specific Characters in the Extinct Genus Coryphodon, M. Charles Earle shows that it is exceedingly difficult in this group to find where one species ends and another begins. In most cases the characters run into each other insensibly. The author believes that there are about eight good species, the characters of which show a progression from the primitive to the more specialized types. A later study by Mr. Earle is on the comparative osteology of the Malayan and the Brazilian tapirs.

DURING a residence in Tunisia, M. Vercoutre made a study of the tattoo marks with which the natives cover their limbs and face. He discovered that the most complete designs represent a human figure—a kind of doll, seen in front, with extended arms. In this figure, for which no explanation had been offered before, he perceives nothing else than a representation, rigidly exact and preserved by tradition without perceptible alteration, of the manikin on the monuments of Phœnicia and Carthage, which archæologists have named the "Symbol of the Punic Trinity"—which is found, for example, on the Phœnician and Punic stelæ, and on the neo-Punic lamps of Carthage.